Empathy and Emotion Processing in Mild Head Injury and Sub-clinical Psychopathy

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Abstract

The current study sought to investigate the nature of empathic responding and emotion processing in persons who have experienced Mild Head Injury (MHI) and how this relationship between empathetic responding and head injury status may differ in those with higher psychopathic characteristics (i.e., subclinical psychopathy). One-hundred university students (36% reporting having a previous MHI) completed an Emotional Processing Task (EPT) using images of neutral and negative valence (IAPS, 2008) designed to evoke empathy; physiological responses were recorded. Additionally, participants completed measures of cognitive competence and various individual differences (empathy - QCAE; Reniers, 2011; Psychopathy - SRP-III, Williams, Paulhus & Hare, 2007) and demographics questionnaires.

MHI was found to be associated with lower affective empathy and physiological reactivity (pulse rate) while viewing images irrespective of valence, reflecting a pattern of generalized underarousal. The empathic deficits observed correlated with the individual's severity of injury such that the greater number of injury characteristics and symptoms endorsed by a subject, the more dampened the affective and cognitive empathy reactions to stimuli and the lower his/her physiological reactivity. Importantly, psychopathy interacted with head injury status such that the effects of psychopathy were significant only for individuals indicating a MHI. This group, i.e., MHI subjects who scored higher on psychopathy, displayed the greatest compromise in empathic responding. Interestingly, the Callous Affect component of psychopathy was found to account for the empathic and emotion processing deficits observed for individuals who report a MHI; in contrast, the Interpersonal Manipulation component emerged as a better predictor of empathic and emotion deficits observed in the No MHI group. These

different patterns may indicate the involvement of different underlying processes in the manifestation of empathic deficits associated with head injury or subclinical psychopathy. It also highlights the importance of assessing for prior head injury in populations with higher psychopathic characteristics due to the possible combined/enhanced influences.

The results of this study have important social implications for persons who have experienced a concussion or limited neural trauma since even subtle injury to the head may be sufficient to produce dampened emotion processing, thereby impacting one's social interactions and engagement (i.e., at risk for social isolation or altered interpersonal success). Individuals who experience MHI in conjunction with certain personality profiles (e.g., higher psychopathic characteristics) may be particularly at risk for being less capable of empathic compassion and socially-acceptable pragmatics and, as a result, may not be responsive to another person's emotional well-being.

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Introduction

Being able to understand and respond to the emotional experiences of others is essential for successful social interaction. The capacity to consider another's emotional status is thought to underlie one's capacity for empathy (Smith, 2006). Our ability to empathize by considering others' emotional and mental states is the driving force governing healthy coexistence amongst humans, and constitutes the very fabric of human moral development and social decision making. While traditionally, empathy has been described as a unitary construct (Feshbach, 1989; Ickes, 1993) encompassing all elements thought to constitute empathic behaviour, e.g., emotional contagion, feeling sympathy, evaluating another's emotional state and helping behavior; under a single mechanism, recent evidence points toward the existence of dissociable sub-systems and neurocognitive processes (Shamay-Tsoory, Aharon-Peretz & Perry, 2009) comprised of separate affective (or emotional) and cognitive components of empathy (Smith, 2006; Blair, 2005).

Affective (or emotional) empathy can be described as sharing the emotional experience of another. It is analogous with the process of emotional contagion which refers to the convergence of affective states between individuals (Hatfield, Cacioppo & Rapson, 1994). According to the perception-action mechanism proposed by Preston and De Waal (2002), the perception of an affective state of another automatically activates shared representations in the observer, thereby inducing a similar emotional state in them. This "affect-sharing" enables individuals to emotionally connect (Hatfield et al., 1994). Affective empathy, at its most primal level (emotional contagion) is thought to rely on our innate and automatic ability to mimic. For instance, in humans, studies on mimicry report that infants within the first few months of life can begin to imitate certain facial expressions (Kalat, 2009). They also show evidence of emotional resonance at birth such that when one baby begins to cry in a nursery, others quickly follow

(Panksepp & Panksepp, 2013). Studies assessing rapid facial muscle movements [detected via facial electromyography (EMG)] in response to facial expressions report that individuals not only unconsciously elicit different facial EMG changes in response to different emotional expressions (including positive and negative expressions), but also report feeling the corresponding emotion (Dimberg, Thunberg & Elmehed, 2000; Lundqvist & Dimberg, 1995). Dimberg and Thunberg (2012) directly tested the relationship between facial mimicry and affective empathy. The authors examined the facial reactions of subjects presented with pictures of facial expressions of emotion, and whether individuals with greater affective empathy were better able to experience an emotion similar to that expressed in the stimuli. In the study, participants were divided into low or high empathy based on their performance on a standardized measure, and then exposed to pictures of happy and angry faces while their facial muscle movements (EMG) were recorded. Interestingly, individuals rated higher on empathy more successfully differentiated happy and angry stimuli (via their facial muscles) and demonstrated greater muscle activity to emotional faces as early as 500 milliseconds after stimulus onset. They also had a higher incidence of experiencing the corresponding emotion that was portrayed. The low empathy participants, in contrast, did not differentiate happy and angry stimuli with either facial muscles or their personal experience. Thus the rapid and spontaneous elicitation of facial mimicry to emotional cues serves as a crucial mechanism for emotional and empathic contagion (Dimberg & Thunberg, 2012), and may be present since birth (Kalat, 2009; Panksepp & Panksepp, 2013).

The capacity for emotional contagion and affective empathy has been shown to rely primarily on the mirror neuronal system (MNS) which includes regions of the parietal and pre-motor cortex as well as several interconnected subcortical-cortical structures which together

constitute the limbic system. These include: the hypothalamus, the parahippocampal cortex, the amygdala, septum, basal ganglia (BG), nucleus accumbens (NA), the anterior insular cortex (AIC), the anterior cingulate cortex (ACC) and prefrontal cortex (PFC) (Decety, 2010a). The amygdala, the ventral medial prefrontal cortex (vmPFC) and somatosensory cortices are particularly highlighted in the experience of affective empathy (Decety, 2010a; Decety, 2011).

Traditionally, the concept of empathy was limited to including, and defined by, the various components of affective empathy (Panksepp, 2012). However, in humans, empathy is not just restricted to "affect-sharing" (affective empathy) but also includes "perspective-taking" (sympathy) (De Waal, 2008; Singer, 2006). While affective empathy involves *sharing* the emotional experience/feelings of another with little distinction between the self and the other, sympathy is concern for another but *without sharing* the affective state (Decety, 2010a; De Waal, 2008; Singer, 2006). Therefore, sympathy may emerge from considering another's affective state but does not have to necessarily be congruent with another's emotional state (Decety, 2010a). Here, the distinction between the self and the other is pronounced (Decety, 2010a; De Waal, 2008). In other words, affective empathy is feeling another's pain or distress via "affect-sharing" and is regulated by the MNS and the limbic system; sympathy is concern for another elicited by considering their emotional state (Decety, 2010a). In this sense, sympathy is more analogous with "cognitive empathy" which is described as the ability to understand the emotions of others and is thought to rely predominantly on one's capacity to mentalize others' emotional state via the process of perspective-taking or Theory of mind (Singer, 2006). This capacity of "mental attribution" of others' mental states (Singer, 2006) has been shown to rely primarily on cortical structures, particularly the PFC and ACC (Decety, 2010a; Decety, 2011).

The existence of dissociable sub-systems mediating the experience of empathic behaviour is further corroborated with evidence from animal studies that share the same mammalian brain structures as humans. As previously mentioned, the capacity for affective empathy relies on sub-cortical limbic structures as well as somatosensory cortices. These regions are phylogenetically old and shared across all mammalian species and thought to underlie their capacity to care for their young by being responsive to critical emotional cues such as hunger, pain, distress and fear in their offspring (Decety; 2011). This maternal nurturance system is likely responsible for the foundations of empathic behaviour in mammals (Decety; 2011; Panksepp & Panksepp, 2013). Empathy-like behaviour in mammals is not confined to nurturing-type behaviour/emotions but has been observed in other states as well. For instance, Langford and colleagues (e.g., Langford et al., 2006) demonstrated "emotional contagion" in rats with respect to pain. Rats that observed a cage-mate receiving a known painful shock produced a heightened number of 'mirrored' twitches (indicative of perceived pain experience); interestingly, the number of twitches produced by these 'paired' rats substantially decreased when these rats were blinded (Mogil, 2012a; Mogil, 2012b). The findings implicate the critical role of visual information in eliciting emotion contagion likely through the process of mimicry and affect recognition. Consistent with these findings, in a classic study by De Waal and van Roosemalen (1979), chimpanzees demonstrated reconciliation (kissing) and consolation (hugging) type behaviours directed towards combatants after an aggressive episode. Similarly, Parr (2001) reported greater parasympathetic arousal in chimpanzees while they viewed negative video scenes of their conspecifics in distress (being injected with needles), relative to control videos. Nonetheless, the existence of higher level cognitive components of empathy such as theory of mind and perspective taking in non-human species remains controversial and unsubstantiated.

While many brain structures mediating the affective components of empathy are shared across mammals, humans are unique in that the cortical areas responsible for the cognitive abilities underlying complex perspective-taking are layered on top of the phylogenetically older structures that mediate social and emotional capacities (Decety, 2011, p. 36). This enables humans to use higher order functions like language and executive functioning to regulate and modify emotional experience and empathy in ways not observed in other species (Decety, 2011; De Waal, 2008; Panksepp & Panksepp, 2013; Singer, 2006).

Based on the literature presented above, empathic behaviour as observed in humans includes: phylogenetically old "affective" components which likely developed as a function of the mother-child bond and is shared across all mammals; as well as "cognitive" components reliant on the phylogenetically newer cortical regions responsible for executive functioning and language (Decety, 2011). Considering the multi-faceted nature of empathy several models of empathy have been proposed.

De Waal (2008) describes empathy as a series of Russian dolls with each higher level of empathy building upon the hard-wired socio-affective core. According to the "Russian doll" model, the development of empathy includes all the ways in which one individual's emotional state affects another's with primal mechanisms at its core and more complex mechanisms at its outer layers. According to the model, at the core lies the perception-action mechanism which enables the process of "affect sharing" via emotion contagion. Sympathetic concern and perspective-taking constitute the outer layers. According to the model, the outer layers are contingent on prefrontal functioning, and remain connected to the inner core which is mediated by limbic structures.

Similarly, Panksepp (2011) proposed the "nested hierarchies of control" model. This model describes empathic behaviour as being multi-tiered, encompassing three levels of analysis within the brain: the primary, secondary and tertiary processes. Primary process empathy includes empathy in its most basic forms such as emotional contagion and motor mimicry which likely developed in mammals as a maternal nurturance system. These are "bottom-up" processes that likely originate in the medial regions of the upper brainstem and are preserved in all mammals. Secondary empathy processes involve both bottom-up (learning) and "top-down" (memory) processes based on prior reward/punishment contingencies and are mediated by the intermediate structures of the brain such as the basal ganglia and upper limbic regions. Tertiary empathy processes are indicative of top-down processes and include cognitive abilities such as thinking, ruminating and theory of mind and are accomplished by neocortex, particularly the prefrontal cortex (Panksepp, 2011; Panksepp & Panksepp, 2013). Consistent with De Waal's (2008) model, the capacities of tertiary processes are permitted by lower level arousal and consciousness, thus requiring interactions across the levels (Panksepp & Panksepp, 2013, p. 491).

Decety (2010b) proposes a model of empathy involving several distinct and interacting neurological processes that contribute to the overall experience of empathy. In this model are three distinct, but interacting, processes which include: 1) Affective arousal (indicative of primary processes) 2) emotion awareness and understanding (indicative of secondary processes) and 3) emotion regulation (indicative of tertiary processes) (p. 259). According to the authors, affective arousal refers to the process of conveying information regarding the valence of the stimulus. Based on this information (likely through visceral feedback), a determination is made

regarding the valence of the stimulus (i.e., whether the stimulus conveys pleasantness/unpleasantness or approach/avoidance). This "bottom-up" process occurs automatically and recruits several subcortical structures including limbic structures, such as the amygdala and hypothalamus, as well as the OFC. Emotional awareness relies on being able to match one's homeostatic status with the demands of the sensory environment. Thus, in lieu of threat, the body needs to become aroused in order to be aware of impending danger and respond adaptively. This is accomplished by the anterior insula which integrates homeostatic status with the sensory environment. This, in turn, may be regulated as a function of the evaluation of the motivational or social demands which are managed by the PFC. For instance, fear that is evoked while watching a scary movie can be "down-regulated" by information from the OFC (which includes the dorsal lateral prefrontal cortex - dlPFC, vmPFC and ACC; evaluation results in the acknowledgment that the situation is artificial and not a real danger). Thus, emotion regulation refers to being able to control emotion and affect by exerting "top-down" modulatory effects in the context of the environmental demands, drive and motivation. The effective cross-talk between these regions and their reciprocal connections with subcortical structures plays a crucial role in the regulation of emotion and empathic response (Decety, 2010b).

Thus, the theoretical models reviewed, all agree that the experience of empathy involves a complex network of distributed processes. Effective interaction across many regions is essential for successful modulation of emotional response and appropriate empathic behaviour. Further, essentially all agree that while affective empathy is primarily driven by autonomic arousal and emotive experience and relies on bottom-up processes; cognitive empathy relies on executive function (e.g., attention, working memory, inhibition) and emotional regulation both of

which are mediated by "top-down" processes. In this sense, while affective empathy is an automatic, involuntary process, cognitive empathy can be consciously regulated or induced.

Understanding that the construct of empathy has various component processes (i.e., at the least an affective one and a cognitive one) has several important implications. It not only allows us a more detailed understanding of the distinct psychological and neural underpinnings of empathy, but also permits investigation into the nature, or expression, of empathy observed in different psychopathologies and groups that display empathic deficits. The current research aims to explore the nature of empathy and its constituent parts in two populations known to show empathic difficulties that often lead to challenges in their successful social and community reintegration. These include: 1) individuals presenting with high psychopathic tendencies or traits (Blair, 2005); and 2) individuals who have experienced a traumatic brain injury (TBI) (Greene & Haidt, 2002).

Empathy in Psychopathy

Psychopathy is a serious developmental disorder characterized by a collection of interpersonal, affective and behavioural features (Hare 1991, 2003). The interpersonal and affective features of psychopathy include characteristics such as manipulativeness, feelings of grandiosity, callous affect and lack of empathy and remorse. The behavioural features of psychopathy, on the other hand, include characteristics like impulsivity, risk-taking and anti-social acts. Thus, the definition of psychopathy involves two factors or components: emotional dysfunction and socially deviant behaviour (Blair, 2005). The interpersonal and affective features of psychopathy together constitute primary psychopathy, while the behavioural features constitute secondary psychopathy (Hare, 2003). Primary psychopathy (e.g., Wai & Tilliopolos,

2012) and, in particular, the characteristic of callous affect constitutes the hallmark cluster of characteristics of psychopathy, and remains the focus of many intervention and rehabilitation efforts.

Currently, there are two main perspectives regarding emotion processing in psychopathy (Brook, Brieman & Kosson, 2013). The first is associated with a global deficiency in the processing of all emotions – a "general emotional deficit". According to Brook and colleagues (2013) this diminished ability to experience emotion hinders one's ability to appreciate the significance of emotions in social interactions and the emotional impact of one's actions on others, and together, is manifested as a lack of empathy. According to this viewpoint, cognitive deficits are secondary to the compromise in emotional processing; despite being cognitively intact, the absence of emotion renders these individuals unable to anticipate the outcomes of their actions for themselves and/or others (Brook et al., 2013). Alternatively, the "specific emotional deficit hypothesis" presumes that the emotional deficits in psychopathy are not global and, rather, pertain to specific types of emotions; for instance, Blair (2005) proposed that psychopaths are compromised in their understanding and response to cues associated with negative emotions, such as sadness and fear (Brook et al., 2013); rendering the psychopath immune to the elicitation of affective mirroring of negative emotion which in turn gets manifested as a lack of empathy.

It has been proposed that being able to recognize facial expressions serve important "communicatory functions", and guide successful social interaction by providing important cues to the observer (Blair, 2003). For instance, while happy expressions may serve as "reinforcers" and elicit approach behaviours, negative facial expressions such as sadness or fearfulness, serve as "aversive" signals that elicit avoidance behaviours (Blair, 2003). Consequently, difficulties in identifying emotional expressions may interfere with effective "knowledge translation", which

otherwise would serve in inhibiting aggressive behaviours and activating pro-social responding, and consequently is manifested as an absence of empathy (Blair, 2003; Blair, 2005).

Studies assessing emotion processing in psychopathy have found that characteristics of psychopathy are associated with poor affect detection such that individuals scoring high on psychopathy are less able to correctly detect and categorize emotional experiences, particularly those conveying negative emotions (e.g., Eisenbarth, Alpers, Segrè, Calogero & Angrilli., 2008; Snowden, Craig & Gray, 2013). This has been found for both visual (e.g., through facial recognition) and auditory (vocal) modalities. For instance, Blair and colleagues (2002) reported impaired recognition of negative vocal affect in psychopathic individuals, particularly for those voice-bits conveying sadness and fear. Consistently, Brook and Kosson (2013) examined both facial and vocal affect recognition by presenting participants with short videos of non-actors describing past emotional experiences. Relative to controls, psychopaths were less accurate in judging others' emotional states, and displayed the greatest challenge with sad and fearful emotional portrayals (also see Stevens, Charman & Blair, 2001).

Psychopathy has also been associated with significant compromise in the expression of emotion. For instance, psychopaths display reduced autonomic responsivity to distress (Blair, 1999). De Wied and colleagues (2012) examined verbal, facial and autonomic responsivity to videos that were designed to induce empathy, in a sample of male adolescents that were high/low in callous-unemotional (CU) traits. Despite no differences at baseline, adolescents who were high on CU traits reported less empathy, and produced less facial and autonomic responsivity as displayed by reduced changes in heart rate and facial EMG for clips depicting negative emotions, particularly sadness, compared to their low trait counterparts. Another study which examined acoustic features of speech in male offenders reported a failure for psychopathic inmates to

differentiate their tone (unlike non-psychopathic inmates) when verbalizing emotional versus neutral words (Louth, Williamson, Alpert, Pouget & Hare, 1998).

Further evidence of atypical emotional processing witnessed in persons with elevated psychopathic traits comes from their performance on cognitive tasks that use emotional stimuli. Typically, emotional stimuli cause greater cognitive interference than neutral stimuli and increases one's response latencies, in person's with low/no psychopathic traits; whereas, individuals who score higher on these traits do not show this pattern (see Blair & Mitchell, 2009). For example, Mitchell et al. (2006) examined the impact of emotional stimuli on a simple motor task in psychopathic inmates. Participants were required to categorize simple symbols via button presses that were temporarily bracketed with either positive, negative, or neutral visual images presented within the same spatial location as the symbols. While the non-psychopathic group displayed reduced accuracy and slower responding when the symbols were bracketed with emotional (positive or negative) content relative to neutral images, the psychopathic group experienced minimal interference. Other studies have reported superior selective attention (e.g., Hiatt, Schmitt & Newman, 2004) and reduced distractor interference in this population (e.g., Wolf et al., 2012). Interestingly, despite the emotional deficits described, psychopaths are adept at understanding the motivations and actions of others (Blair et al., 1996). They are known to be extremely good manipulators and deceivers and have been described as "intra-species predators" with superficial charm and good intelligence often used to manipulate and deceive their victims (Cleckley, 1976; Hare, 2001). Lorenz and Newman (2002) define this inconsistency as an "emotional paradox" such that psychopaths are able to appraise emotional cues and judge the motivations and mental states of others, but lack the accompanying feelings associated with the emotional cues (Book, Quinsey & Langford, 2007). Book and colleagues (2007) propose the

concept of "callous empathy" in psychopathy such that the empathic deficits observed are not due to being unable to read and assess the mental states of others but rather are due to being unable to react emotionally to them. According to the authors, psychopaths are especially good at making judgements of others' emotional intensity and vulnerability, but don't emotionally react to them.

In fact, studies assessing Theory of Mind (which involve perspective-sharing and are indicative of cognitive empathy) have found that incarcerated psychopaths perform similarly to controls and report no deficits with respect to taking the perspective of others (Blair et al., 1996; Dolan & Fullam, 2004; Richell et al., 2003). Shamay-Tsoory and colleagues (e.g., Shamay-Tsoory, Harari, Aharon-Peretz & Levkovitz, 2010) make a distinction between "cognitive ToM" (which refers to the ability to make inferences about others beliefs and motivations) and "affective ToM" (p. 669), which refers to the ability to make inferences about the emotional states of others), and argue that both processes are needed in order to holistically experience empathy. In a task that examined affective versus cognitive ToM, psychopathy was found to be associated with impairments only in affective ToM, with performance on cognitive ToM relatively preserved. Interestingly, the pattern of results resembled those found with patients who have experienced orbital frontal injury, an area associated with the modulation of emotional responses (Shamay-Tsoory et al., 2010). Similar findings have even been reported in community samples of persons who score higher on psychopathy traits (e.g., Lockwood, Bird, Bridge & Viding, 2013). For instance, Wai and Tilliopolos (2012) recently reported deficits only in affective, but not cognitive, components of empathy in a sample of female university students scoring high on psychopathy traits. Thus, it appears that the empathic deficits observed in

psychopathy are primarily affective in nature, with their cognitive empathy being relatively intact.

Impairment in the processing of affective stimuli such as recognition of emotional expressions and affective prosody has been associated with lesions to the vmPFC and the amygdala (Blair, 2005; Shamay-Tsoory et al., 2003). Considering the difficulties associated with emotion recognition in psychopathy, it can be speculated that the empathic deficits observed in psychopathic individuals may in part be attributed to possible dysfunction in the amygdala-OFC circuitry (Shamay-Tsoory et al., 2010). Consistent with this suggestion, there is research that describes reduced activity in the aINS and ACC, regions associated with integrating salient events/stimuli with visceral information in psychopathy during affective processing (see Decety, Chen, Harenski & Kiehl., 2013). Structural and functional studies provide further evidence of compromise in the vmPFC (Kiehl et al., 2001), the amygdala (Adolphs, Tranel, Damasio & Damasio, 1994) and the inferior frontal gyrus (IFG) (Shamay-Tsoory, Aharon-Peretz & Perry, 2009; Kiehl, 2001) in psychopathy, all of which have been found to be related to the successful modulation and regulation of emotional response.

In summary, based on the literature reviewed, psychopaths (at a clinical as well as sub-clinical level) display an empathic profile which enables them to read and understand the mental states of others'; however, due to their deficits in the affective component which is required to holistically experience empathy, they are less able to recognize the harm or distress inflicted on, or experienced by, another and its potential consequences. Consistent with previous findings, in the current study, it is hypothesized that individuals who score higher on traits of psychopathy will display deficits on measures of affective empathy, while their cognitive empathy will be relatively intact implicating potential amygdala-OFC disruption in psychopathic behaviour.

Empathy in Traumatic Brain Injury

TBI is a major public health concern in North America constituting one third (30.5%) of all injury-related deaths in the United States (Faul, Xu, Wald & Coronado, 2010). According to the Centers of Disease Control and Prevention (CDC), every year an estimated 1.7 million people sustain a form of TBI (CDC, 2003). In a more recent report, Coronado and colleagues (e.g., Coronado, McGuire, Faul, Sugerman & Pearson, 2012) noted that in 2009, this number substantially increased from 1.7 million to approximately 3.5 million people being listed as having a primary or secondary diagnosis of TBI. Thus, the rates of TBI are not only alarmingly high, but are on the rise. Not surprisingly, the economic burden of injuries as a result of TBI is profound. For instance, the direct medical and indirect community (such as loss of productivity) costs associated with TBI were estimated at approximately 76.5 billion dollars in the United States in 2000 (Finkelstein, Corso & Miller, 2006; Coronado et al., 2012).

TBI may result from either closed head or penetrating injuries, with most injuries being closed head in nature. They occur on a continuum of injury severity ranging from mild to moderate to severe, with the majority of brain injuries falling in the mild end of the spectrum (Iverson & Lange, 2009). In fact, at least 75 percent of all TBIs that occur each year are "mild" in nature and include concussions or other forms of mild TBI (Coronado et al., 2012). TBI, regardless of severity, has been associated with poor cognitive and neuropsychological outcomes (e.g., Bigler, 2008; Ponsford, Cameron, Fitzgerald, Grant & Mikocka-Walus, 2010; Vanderploeg, Curtiss, Belanger, 2005). Deficits have been noted in a wide array of domains including executive function (attention, memory, inhibitory control), motor skills, information processing and problem solving (Constantinidou, Wertheimer, Tsanadis, Evans, & Paul, 2012; Vanderploeg et al., 2005). The precise manifestation and extent of cognitive or behavioural

deficits however, may vary as a function of location, severity and nature of injury (Bigler 2008; Stratton & Gregory, 1994).

Due to the nature of most closed-headed injuries, the frontal lobe, particularly the OFC, is vulnerable to disruption due to its proximal location to the bony protrusions of the cranium (Morales et al., 2005). As previously highlighted, the OFC includes the vmPFC as well as the dlPFC which share rich interconnections with various subcortical regions, particularly the limbic system. The interaction amongst these regions plays a crucial role in emotional regulation and the experience of empathic response in humans. Rapid acceleration/deceleration forces generated within the brain due to sudden force impact can lead to multifocal lesions within these sites as well as sheared axonal interconnections between them (Bigler, 2008; Bigler & Maxwell, 2012), thereby altering the experience of empathy and emotional responding in this population.

Both cognitive and emotional deficits have been observed in individuals with lesions to the OFC. In individuals with moderate to severe injuries, damage to this region has been associated with enduring changes in the individual's capacity for decision making as well as changes in personality (Bechara, Damasio & Damasio, 2000). Studies with these patients have demonstrated an inability to anticipate future outcomes of decisions and hence poor decision making outcomes (Bechara, Damasio, Damasio & Anderson, 1994; Bechara et al., 2000). Damasio's "somatic marker hypothesis" (Damsio, Tranel & Damsio, 1991) suggests that following damage to the OFC, and particularly the vmPFC, the individual can no longer experience the emotional/visceral affect that accompanies, and in turn predicts, negative outcome expectencies and, as such, will more likely engage in risk taking behaviour (i.e., the individual is not emotively "cued" that the selection is not a good choice or the situation is otherwise dangerous). According to the authors, the cognitive reasoning used to make advantageous

(effective or "good") decisions is preceded by a non-conscious/automatic/emotive (or "gut") experience (bottom up processes) which enables us to distinguish between, or otherwise recognize/predict good and poor outcomes (often learned from past experiences) (Bechara et al., 1994; Damasio, Everitt & Bishop, 1996). The vmPFC thus plays a crucial role in the modulation of emotional response and incorporates visceral feedback from limbic and peripheral areas of the nervous system.

Others have reported marked changes in personality, such as callous affect reflected in a "general dampening of emotional experience", "poorly modulated emotional response", erratic lifestyle, as well as antisocial behaviour in persons with TBI (Barrash, Tranel & Anderson, 2000; Tranel, Damasio, Denburg & Bechara, 2005). These behaviours share striking similarities with some of the behaviours observed in clinical psychopathy (with the exception of the interpersonal manipulation component of psychopathy). Consequently, these personality changes in TBI are often described as an "acquired sociopathy" ("acquired" since they emerge post-injury as opposed to being evident pre-injury/developmentally) (Barrash et al., 2000; Tranel, 1994). These "sociopathic" manifestations are also witnessed in social decisions associated with morality. Tasks examining moral decision making in these TBI populations have found that individuals with lesions to the vmPFC are more likely to commit personal moral transgressions in lieu of utilitarian considerations and take less time in doing so relative to controls (Ciaramelli, Muccioli, Ladavas & Pellegrino, 2007; Greene, 2001).

Studies assessing emotion processing in TBI have reported enduring deficits in emotion perception (Bornhofen & McDonald, 2008a). For instance, individuals with TBI often present with difficulties in being able to identify and describe emotional expressions (Williams & Wood, 2010), a condition referred to as "alexithymia". Being able to successfully recognize and

understand affective information serves as a necessary precursor in order to induce empathic responses. Failure to recognize emotional distress in another is likely to lead to a dampened empathic response and inappropriate social conduct (Bornhofen & McDonald, 2008a; Blair, 2003; Shamay-Tsoory et al., 2003).

Individuals with lesions to the frontal lobe also display cognitive inflexibility, an inability to mentally switch between thinking about two different concepts, or to think about multiple concepts simultaneously (e.g., Constantinidou, et al., 2012), which may often be manifested as an inability to take the perspective of others (Bornhofen & Mcdonald, 2008a). In fact, in a recent study, deSousa and colleagues (de Sousa et al., 2010) found that relative to controls, individuals with a TBI displayed reduced capacity to empathize both emotionally and cognitively. They also displayed reduced facial responding to unpleasant pictures and rated the pictures as less unpleasant and arousing than matched controls. Consistent with the somatic marker hypothesis, they displayed lowered autonomic arousal to all pictures, regardless of affective valence. This latter finding is important to note since it may be indicative of an important distinction in the etiology of empathic differences observed in psychopathy versus TBI. While TBI displays an *overall* lowered autonomic arousal to emotive stimuli, regardless of valence; psychopathic individuals show flattened physiological response specifically to negative emotions, e.g., sad and fearful facial cues, potentially implicating greater involvement of the amygdala in persons with psychopathic features (Blair & Mitchell, 2009).

While most of these studies focus on moderate to severe TBI, mTBI constitute the majority of all traumatic brain injuries and can range from minor transient injuries to complicated mild injuries (Iverson & Lange, 2009). While, traditionally mTBI, such as concussion, are viewed as “minor” injuries without lasting neuropathology or persistent

physical/behavioural challenges, contemporary neuroimaging techniques employing diffusion tensor imaging (DTI), susceptibility weighted imaging (SWI) and magnetic resonance spectroscopy (MRS) consistently demonstrate persisting metabolic abnormalities associated with mTBI (Bigler & Maxwell, 2012). Most mTBIs involve concussive-type injuries which result from rotational or angular acceleration/deceleration of the brain. The resultant shear/strain forces initiate a cascade of metabolic events that renders the brain in state of "ionic disequilibrium" (Biasca & Maxwell, 2007). In order to restore homeostasis, increased energy demands result in increased glycolysis and lactate accumulation which can cause greater damage (Bigler & Maxwell, 2012; Lin et al., 2012). It is generally accepted that typically two waves of neuronal death occur post TBI. In the first wave, immediately following the injury, neuronal death may be caused by irreversible metabolic disturbance and/or excitotoxicity, cell damage or axonal disconnection due to the magnitude of shearing forces. This is called primary axotomy and is characteristic of more severe injuries. In mTBI, the primary cause of neuronal injury is not due to primary axotomy, but rather a delayed axotomy in which axons are injured following initial changes in the microenvironment. This second wave of neuronal death can occur several days or even months post-injury, and is typically followed by neuronal inflammation that can add to the original metabolic disturbance over time and lead to extended pathology (Biasca & Maxwell, 2007; Bigler & Maxwell, 2012). This second wave of neuronal death may explain some of the persistent symptoms observed in individuals with mTBI (Bigler, 2008; Bigler & Maxwell, 2012). Due to disruption or loss of cellular control to maintain ionic equilibrium required for normal functioning, neuropathology reported in mTBI can range from focal injury to axons in white matter as well as changes in gray matter (Bigler & Maxwell, 2012). Currently, evidence of such injuries in mTBI exists for both. For instance, Holli and colleagues (e.g., Holli et al., 2010)

recently reported abnormal white matter integrity in individuals with mTBI. Interestingly, the compromised white matter integrity was found to be predictive of relatively poor neuropsychological outcome in the mTBI group. Changes in gray matter have also been reported in mTBI (Ling, Klimaj, Toulouse, & Mayer, 2013). Mackenzie et al. (2002) also reported minor volumetric changes in gray matter indicative of mild brain atrophy in mTBI.

Thus, mechanical strain induced as a result of concussive-type injuries alters the cytoarchitechture of axons potentially impairing normal neurologic function. Bigler (2008) discusses a "cone of vulnerability" highlighting the primary regions which are most likely affected as a result of rotational/angular forces characteristic of concussive-type injuries. These include: the frontal regions (including the vmPFC and dlPFC), the temporal polar cortex, the amygdala, the thalamus, the hypothalamus, the entorhinal hippocampal cortex, the ventral brain stem and the cerebellum (due to contra-coupe forces characteristic of whiplash injuries).

The brain has been found to be particularly vulnerable to repetitive concussions, common in high contact sports. These may cause cumulative damage potentially leading to persistent symptomology witnessed in this cohort. Weber (2007) investigated the effects of repeated trauma in cultured brain cells subject to stretch-induced mechanical forces. The extent of damage was found to rely on the time between repeated injury. For instance, while a very "low level" stretch did not result in cell damage on its own, the same mechanical stretch produced cumulative cell damage when repeated several times at short intervals. These findings are important in that they challenge the conventional mindset that one may need to experience a substantial blow to the head in order to experience persisting symptoms associated with head trauma. These findings suggest that several "low level" force/impact injuries to the head,

common in high contact sports such as hockey, may be sufficient to induce cell damage and mimic relatively more “severe” injuries.

If viewed on a continuum ranging from mildest to most severe, the neuropathology observed in more severe cases are likely to inform us of neurobehavioural challenges observed in those with less severe injuries, including mild head injuries (Bigler, 2008). In fact, individuals reporting a previous history of MHI have been shown to mirror the effects witnessed in more severe groups, albeit to a subtler extent. Consistent with those with more severe brain injuries, they perform differentially on social decision making tasks (Chiapetta & Good, 2009), are less sensitive to social affective cues (e.g., facial expression) (van Noordt & Good, 2010) and show reduced physiological arousal (e.g., EDA, heart rate) (Baker & Good, 2013) relative to their No MHI cohort. Together, these studies suggest that individuals with a MHI respond differently to emotional stimuli.

Potential differences in moral decision making have also been observed in this group. In a recent study examining moral decision making in university students reporting a previous history of head injury, participants completed a moral decision making task which varied in terms of intentionality (Indirect, Direct) and type of transgression outcome (non-moral, non-physical harm, and physical harm). Each dilemma involved an individual engaging in a particular course of action which would indirectly (individual as passive agent) or directly (individual as active agent) bring about a particular outcome. Participants were then asked to evaluate their likelihood of engaging in that particular course of action (Willams, 2013). Consistent with the pattern of moral decision making behaviour found in persons with more severe TBI, the results demonstrated that individuals with self-reported MHI were significantly more likely to endorse utilitarian moral transgressions relative to their no-MHI cohort. That is,

persons with MHI were as likely to endorse committing physically harmful transactions (e.g., murder) as being acceptable if it supported the "greater good" as they were to endorse non-physical transgressions (e.g., stealing) – a finding that is usually rejected due to the emotive/affective component that influences decision making, potentially indicating a "lack of empathy". Interestingly, an interaction between personality (psychopathic traits) and head injury was found such that individuals scoring high on sub-clinical psychopathy traits who also had a history of head trauma produced the most extreme responding with respect to moral dilemmas. They were not only most likely to endorse direct moral transgressions leading to physical harm; but also did not differentiate in their ratings as the transgression outcomes increased in severity (from non-moral to direct physical harm) relative to the No MHI/low psychopathy groups but rather treated all as equally appropriate actions (Sharan & Good, 2012). Based on these findings, it is evident that having a history of head trauma in conjunction with a certain "at-risk" personality profile (e.g., high rates of psychopathy traits) may exacerbate the "lack of empathy" observed. To our knowledge, this study was the first to examine head injury in conjunction with personality factors in individuals with mild head injury. These findings are in line with some recent statistics reporting the high incidence of TBI and brain abnormalities in incarcerated youth and adults (Schiltz, Witzel, Bausch-Hölterhoff, & Bogerts, 2013; Farrer & Hedges, 2011). Thus, studying neurobehavioural sequelae post head injury in conjunction with personality factors may have important implications as certain individuals may be at particular risk of poor social functioning, and these may impact their quality of social relationships.

By inducing an empathic response in the context of affective and cognitive components of an Emotion Processing Task (EPT) (via negatively-valenced pictures and scenarios), the current study investigated the nature of empathy and emotion processing in Mild Head Injury

(MHI) and the influence of individual differences associated with psychopathic traits (sub-clinical).

Hypotheses

Hypothesis I. Based on the literature, it was expected that, relative to their no-MHI cohort, individuals with MHI would display lower affective and cognitive empathy. Conversely, individuals who endorsed higher scores on subclinical psychopathy were expected to demonstrate less affective, relative to cognitive, empathy.

Hypothesis II: Physiologically, individuals reporting a previous history of head injury were expected to show reduced physiological arousal (with respect to pulse and EDA amplitude) overall, whereas individuals scoring higher on psychopathy were expected to show reduced physiological arousal, specifically with respect to negatively valenced stimuli.

Hypothesis III: In accordance with the severity continuum of MHI, differences in empathy and physiological arousal were expected to be more pronounced as a function of injury severity.

Hypothesis IV: Additionally, as per previous findings from our lab (Sharan & Good, 2012), MHI status was expected to interact with one's level of endorsed psychopathy traits such that individuals reporting a history of MHI and who scored higher on measures of subclinical psychopathy would reflect the greatest compromise in affective and cognitive empathy which would also be concurrently reflected in reduced physiological arousal.

Method

Participants

One-hundred and fourteen participants were recruited from the research pool at Brock University to participate in the study. Exclusion criteria of the study included any participant reporting a diagnosed psychiatric (n = 6) or neurological (n = 2) condition concurrently on neuroleptic medication. Further, due to the importance of English comprehension for the 'context manipulation' for Trial 2, one participant who reported English as his second language and who clearly demonstrated difficulty understanding or following instructions of the tasks was excluded. Additionally, subjects were excluded if identified as significant outliers (n = 3; $z \geq \pm 3$), or non-completion of the study (n = 1), or non-compliance (n = 1). Our final dataset thus included 100 participants, with a mean age of 21.63 (*SD* = 5.35) years. Fifty-three percent of the sample was female. The majority of our sample reported being Caucasian (67 %), with the remaining participants reporting European (7%), East Indian (6%), Hispanic (4%), African (3%) Chinese (3%), West Indian (3%), Middle Eastern (3%) and Other (4%).

MHI and Severity Classification. A head injury is defined as "any injury to the head with a force sufficient to alter one's state of consciousness (e.g., dizziness, confusion, seeing stars)" (e.g., Kay et al., 1993). Thirty-six participants met this criterion. The MHI group comprised of 69% male participants (*n* = 25; *n* = 11 female), whereas the no-MHI group comprised of 34% male participants (*n* = 22, *n* = 42 female). Sixty-nine per cent of the MHI participants reported localized impact injury, while the remainder acknowledged diffuse, multiple-site injuries. While males had a greater incidence of multiple-site and complex injuries than females, the pattern was the same, with the leading cause of injuries being sports-related. A

summary of participants' injury characteristics (e.g., symptomology, mechanics, cause) pertaining to their most recent injuries is presented in Table 1 as a function of gender.

Table 1.

Descriptive statistics of injury characteristics reported by participants within the MHI group as a function of Gender

Injury Characteristics	Female		Male	
	n (%)		n (%)	
Altered state of consciousness (e.g., dizziness, confusion, seeing stars).	11 (100.0)		25 (100.0)	
More than one injury	3 (27.3)		14 (56.0)	
Maximum number of injuries	4 (9.1)		8 (8.0)	
	Injury 1[a]	Injury 2[b]	Injury 1	Injury 2
Additional Symptom Presentation				
nausea/vomiting	3 (27.3)	0 (0.0)	0 (0.0)	0 (0.0)
impaired vision/hearing	1 (9.1)	1 (9.1)	4 (16.0)	2 (8.0)
concentration difficulties	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.0)
PTA	1 (9.1)	0 (0.0)	2 (8.0)	0 (0.0)
headaches/migraines	3 (27.3)	0 (0.0)	5 (20.0)	1 (4.0)
Symptoms > 20 minutes	10 (91.9)	1 (9.1)	9 (36.0)	3 (12.0)
Loss of Consciousness (LOC)	6 (54.5)	0 (0.0)	12 (48.0)	3 (12.0)
Less than 5 minutes	5 (45.5)	0 (0.0)	9 (36.0)	3 (12.0)
Less than 30 minutes	1 (9.1)	0 (0.0)	3 (12.0)	0 (0.0)
Site of Impact				
Front	3 (27.3)	0 (0.0)	5 (20.0)	4 (16.0)
Back	4 (36)	1 (9.1)	8 (32.0)	3 (12.0)
Right	0 (0.0)	0 (0.0)	2 (8.0)	0 (0.0)
Left	2 (18.2)	1 (9.1)	1 (4.0)	0 (0.0)
Multiple	1 (9.1)	1 (9.1)	4 (16.0)	2 (8.0)
Diffuse	0 (0.0)	0 (0.0)	2 (8.0)	1 (4.0)
Unknown	1 (9.1)	0 (0.0)	3 (12.0)	4 (16.0)
Cause of Injury				
Sports-related Injury	3 (27.3)	1 (9.1)	16 (64.0)	8 (32.0)
Falls	3 (27.3)	1 (9.1)	2 (8.0)	4 (16.0)
MVC	3 (27.3)	0 (0.0)	1 (4.0)	1 (4.0)
Other	2 (18.2)	1 (9.1)	6 (24.0)	1 (4.0)
Result in a diagnosed concussion	8 (72.7)	1 (9.1)	8 (32.0)	4 (16.0)
Required stitches	2 (18.2)	0 (0.0)	2 (8.0)	3 (12.0)

Receive medical treatment	7 (64)	0 (0.0)	6 (24.0)	6 (24.0)
Stayed overnight in hospital	2 (18.2)	0 (0.0)	1 (4.0)	1 (4.0)

Note. PTA = Post Traumatic Amnesia, LOC = Loss of Consciousness, MVC = Motor Vehicle Collision

[a] Injury 1 refers to the most recent injury indicated; [b] Injury 2 refers to 2nd most recent injury indicated in case multiple injuries were reported.

Despite all head injuries being classified as "mild", as seen in Table 1, considerable variability in symptomology was indicated. For instance, in addition to reporting an "altered" state of consciousness, several participants endorsed other more "severe" symptomology such as loss of vision, tinnitus, Post Traumatic Amnesia (PTA), loss of consciousness (LOC) etc., in association with their MHI. Moreover, 17 participants (47% of the MHI group) reported sustaining more than one head injury. Repeated injury to the head has been associated with increased neurological compromise due to the compounding effects of injury (Weber, 2007). Given these factors, a severity continuum (consistent with Iverson & Lange, 2009) was developed based on the symptom complications and number of head injuries reported. A severity index based on the two most recent injuries reported (in case of more than 2 injuries) was created, including: report of altered state of consciousness (no = 0, yes = 1); presentation of additional symptoms, i.e., nausea/vomiting (no = 0, yes = 1), impaired/loss of vision or hearing (no = 0, yes = 1), memory, concentration difficulties (no = 0, yes = 1), PTA (no = 0, yes = 1), and migraines/headaches associated with injury (no = 0, yes = 1); duration of symptoms lasting more than 20 minutes (no = 0, yes = 1); loss of consciousness (no = 0, yes = 1); duration of LOC (less than 5 minutes = 1, less than 30 minutes = 2); whether the injury resulted in a diagnosed concussion (no = 0, yes = 1); whether stitches were required (no = 0, yes = 1); whether medical treatment was sought (no = 0, yes = 1); whether admission to the hospital occurred (no = 0, yes =

1); and the total number of injuries sustained (Range from 0 to 8). All potential effects of injury severity were examined using this severity index which ranged from 0 (no injury) to 22, with higher numbers reflecting greater severity of injury.

Categorization of Psychopathy. Participants were also categorized into two groups based on a nonclinical measure of psychopathy: those scoring relatively "lower" versus those scoring relatively "higher" (Table 2) on the Self Report Psychopathy scale (SRP-III) (detailed in Materials, Pg. 34).

Table 2.

Frequency of male and female participants as a function of their Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) classification

Psychopathy Status	Males n (%)	Females n (%)
	No MHI	
Lower	13 (59.1)	37 (88.1)
Higher	9 (40.9)	5 (11.9)
	MHI	
Lower	11 (44.0)	10 (90.9)
Higher	14 (56.0)	1 (9.1)
Total	47 (100.0)	53 (100.0)

Note. MHI = Mild Head Injury.

Participants indicating a total psychopathy score of 164 (see below) and lower were classified as "low psychopathy" (n = 71), while those with a total psychopathy score greater than 164 were classified as "high psychopathy" (n = 29). Global psychopathy scores from the SRP-III were used for this purpose as it has shown to better capture the 4-facet structure of psychopathy and hence reflect better construct validity relative to other measures of sub-clinical psychopathy

(Hare, 2003; Paulhus et al., 2007) in student populations. Median splits conducted on global psychopathy scores for male participants (*M* = 165.41, *Mdn* = 164.00, *Mode* = 173.00; females: *M* = 138.94, *Mdn* = 140.33, *Mode* = 148.00) were applied to all subjects for the primary reason that psychopathy as a construct is better understood in males, with its manifestation in females in current literature being unclear (for a detailed review see Forouzan & Cooke, 2005; Cale & Lilenfeld, 2002) and males typically scoring higher on psychopathy relative to females (Paulhus et. al, 2007). Thus, only those females (n = 6) who indicated scores comparative to those scoring "higher" in males (i.e., > 164, n = 23) met the "high psychopathy" cut-off. It is important to note that these classifications were established to capture individuals scoring relatively higher on a subclinical measure of psychopathy and in no way are indicative of psychopathy in forensic populations. The limitations of categorizing a continuous measure as detailed by Cohen (1983), are duly noted and acknowledged[1].

Materials

Measures of Empathy and Emotional Processing

Emotional Processing Task (EPT). In order to assess differences in emotional processing and empathic capacity, participants completed an emotional processing task designed to evoke empathy. Participants were presented with images of Neutral or Negative valence and asked to provide ratings on Empathy (1 = *no empathy*, 5 = *moderate*, 9 = *extreme)*, Arousal (1 = *not at all*, 5 = *moderate*, 9= *extreme*), Intensity (1 = *not at all*, 5 = *moderate*, 9= *extreme*) and

[1] Accordingly, all hypothesized and observed effects, while analyzed as a categorical variable, were confirmed using multiple regression analyses with psychopathy scores entered as a continuous variable after controlling for gender. This did not change the overall pattern of results and will not be described in detail unless specified otherwise.

Pleasantness (1 = *unpleasant*, 5 = *neutral*, 9 = *pleasant*) elicited by the image (Trial 1). Participants were subsequently presented with the same image but on second presentation (Trial 2) the image was accompanied by a statement that provided a verbal context (through scenarios) that either confirmed or altered the primary emotional impression depicted during the first presentation of the picture (according to standardized ratings, see Section C of the Appendix for an item-by-item description). Again, participants were asked to rate each on Empathy, Arousal, Intensity and Pleasantness. While ratings collected at Trial 1 provided a measure of *Affective* empathy, ratings following the scenarios (i.e., Trial 2) provided a measure of *Cognitive* empathy. Each image (across both trials) was presented for a fixed duration of 8 seconds followed by the presentation of each of the rating scales. Participants were required to select their rating via a hand-held mouse.

A set of 24 emotive images (12 Neutral valence, 12 Negative valence) from the normative database of the International Affective Picture System (IAPS - Lang, Bradley & Cuthbert, 2008) were selected on the basis of those that evoked the highest empathy ratings (as indicated on pilot data collected in our lab). All images (and scenarios) were counterbalanced and presented in one of two randomized orders. An item-by-item analysis as a check/verification of the manipulation, eliminated 5 images (3 Neutral valence, and 2 Negative valence) from the dataset (i.e., they were found to not produce ratings consistent with the intended valence; e.g., items that were originally identified as “neutral” produced substantive negative ratings). The remaining images produced variances that were relatively stable and compatible with the valence of the image (see Table 3). Thus, analyses for the EPT were based on a set of 19 images (9 Neutral, 10 Negative).

Manipulation Check. In order to verify the effectiveness of the materials (i.e., images and scenarios) used in the EPT, ratings of each of the behavioural scales, namely Empathy, Arousal, Intensity and Pleasantness, were examined. For Trial 1 ratings, separate repeated measures analysis of variance (ANOVA) tests were conducted for each scale with Image Type (2 levels - Neutral, Negative) entered as a within-subjects factor. A main effect of Image Type was observed for each ($p < .001$). As intended, Neutral images were rated as evoking less empathy, being less arousing and intense and more "neutral" relative to the Negative images (Figure 1). The reader is referred to Table 4 detailing results from the ANOVA across the different behavioural scales.

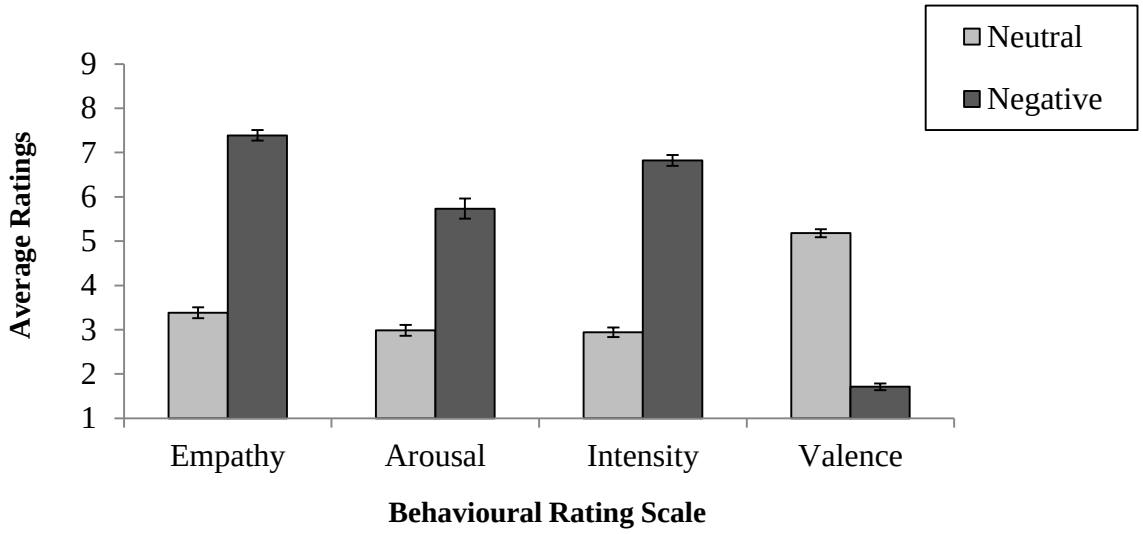

Figure 1. Participants' average ratings on the behavioural scales as a function of Image Type (Neutral, Negative). Error bars represent standard errors.

In order to verify the effectiveness of the scenarios used in the EPT, behavioural ratings on Trial 2 were examined. Separate 2 x 2 repeated measures ANOVAs were conducted for each behavioural scale with Image Type (Neutral, Negative) and Context (Confirming, Contrasting)

entered as within-subjects variables. Ratings were thus examined across 4 resulting conditions, namely, Neutral-Neutral (Confirming), Neutral-Negative (Contrasting), Negative-Negative (Confirming) and Negative-Neutral (Contrasting). The Neutral-Negative and the Negative-Negative conditions were expected to elicit greater emotional reactivity and thus to be rated as evoking greater empathy, arousal, and intensity and as being more "unpleasant". A significant interaction for Image Type and Context was observed for each behavioural scale ($p < .001$), corroborating the effectiveness of the intended manipulation. Overall, the neutralizing conditions, i.e., the Neutral-Neutral and Negative-Neutral conditions, produced lower empathy ratings relative to the conditions intended to evoke empathy, i.e., the Negative-Negative and the Neutral-Negative conditions. Similarly, the neutralizing conditions were also rated as less arousing and intense, as well as rated as less "unpleasant" and more "neutral" relative to the negative scenarios which were intended to evoke heightened emotional reactivity As seen in Figure 2, the increase in empathy, arousal, intensity, and unpleasantness ratings for the empathy conditions was especially strong for the Negative-Negative trials which evoked substantially higher ratings relative to the Neutral-Negative conditions. Again, the reader is reminded that a rating of "5" on the valence scale is indicative of a "neutral" response with lower scores indicative of an "unpleasant" response and higher scores indicative of a "pleasant" response. Higher ratings on all other scales are indicative of greater emotional reactivity. The reader is referred to Table 5 detailing results from the ANOVA across the different behavioural scales.

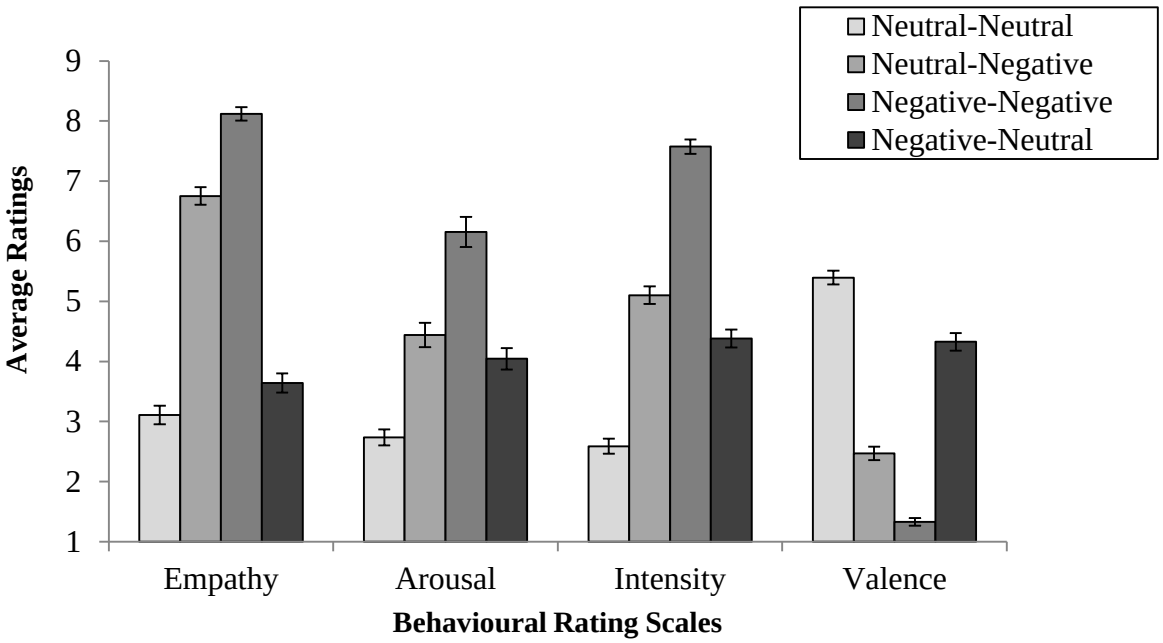

Figure 2. Participants' average ratings on the behavioural scales as a function of Image Type (Neutral, Negative) by Context (Confirming, Contrasting) on Trial 2. Error bars represent standard errors.

Physiological Measures. As an index of one's emotional reactivity, in addition to participants' ratings of arousal (collected during the EPT), participants' physiological arousal in terms of electrodermal activity (EDA) and heart rate (HR) was collected. Recordings were collected continuously across the session and allowed evaluation of physiological responses during the viewing of the images separate from the rating of the four ratings (i.e., empathy, intensity, arousal, pleasantness). A 3-minute physiological baseline was collected prior to beginning the EPT and stabilization was assessed again at the end of the EPT.

All physiological data were collected using equipment from the Polygraph Professional Suite (Limestone Technologies, 2008). In order to measure EDA activity, two gold-plated electro-pads were placed on the index and fourth finger of the participants' non-dominant hand. EDA was measured in terms of EDA amplitude (i.e., trough to peak of the response) while

participants viewed and rated images on the EPT. HR was acquired using a non-invasive pulse oximeter placed on the middle finger of the participant's non-dominant hand. As per the equipment used, HR was determined via pulse pressure changes of one's cardiac cycle and measured in beats per minute (BPM). In order to examine physiological arousal while viewing images, EDA and HR data was sampled from an 8-second latency window from the onset of each image. Averages with respect to EDA amplitude and pulse rate were calculated by the software, specifically the Polygraph Professional Suite. All data were manually screened for artefact prior to conducting analyses.

1. ***The Questionnaire of Cognitive and Affective Empathy (QCAE)***. The QCAE (Reniers, Corocoran, Drake, Shryane & Vollm, 2011) is a 31-item self-report questionnaire that captures the Affective and Cognitive factors of empathy and comprises five sub-scales. The Affective empathy factor includes: *Emotion Contagion* which assesses one's capacity to automatically mirror the emotion of others (e.g., "I am happy when I am with a cheerful group and sad when the others are glum"); *Proximal Responsivity* which assesses one's affective responsivity to another's distress in a social context (e.g., "I often get emotionally involved with my friends' problems"); and *Peripheral Responsivity* which assesses one's affective responsivity to another's distress in a detached context (e.g., "I usually stay emotionally detached when watching a film"). The Cognitive empathy factor includes: *Perspective Taking* which assesses one's ability to take the perspective of another (e.g., "I can easily work out what another person might want to talk about"); and *Online Simulation* which assesses the "effortful" attempt of an individual to consider another's emotional status by imagining their mental state (e.g.,

"Before criticizing somebody, I try to imagine how I would feel if I was in their place"). Participants rate the extent to which each statement describes him/her on a 4-point Likert scale (1= *strongly agree* to 4= *strongly disagree*). The QCAE has demonstrated good construct validity and reliability, across genders (Reniers et al., 2011).

Measure of Psychopathy

***The Self-Report Psychopathy Scale (SRP-III*).** The SRP-III (Williams, Paulhus & Hare, 2007) consists of a 64-item scale that effectively captures the 4-facet construct of psychopathy as postulated by Hare (2003). The SRP-III comprises two factors or four inter-correlated, yet independent, subscales: the Primary factor includes Interpersonal Manipulation (e.g., "I think I could "beat" a lie detector") and Callous Affect (e.g., "Most people are wimps) which capture the affective characteristics (emotional deficiency traits) of psychopathy; the Secondary factor includes Erratic Lifestyle (e.g., "I'm a rebellious person") and Antisocial behaviour (e.g., "I have never been arrested") which capture the behavioural characteristics (social deviance & risk taking traits) of psychopathy. Participants rate the extent to which each item describes his/her behaviour using a 5-point scale ranging from 1 = *disagree strongly* to 5 = *agree strongly*. This questionnaire was specifically developed for assessing characteristics of psychopathy in university and non-clinical populations and has demonstrated good construct and ecological validity in this cohort (Williams, Paulhus & Hare, 2007).

Measures of Cognitive Function

In order to verify participants' cognitive status and to ensure that variability in ratings did not differ as a function of the participant's cognitive capacity, neuropsychological performance on measures of "general cognition" was also assessed.

Similarities. The Similarities Task (Wechsler, 2008) is a standardized neuropsychological subtest of the verbal comprehension index of the Wechsler's Adult Intelligence Scale (WAIS-IV), and is designed to assess one's capacity for verbal reasoning. The participant is presented with two words which share a common concept and asked to describe how they are similar (e.g., "In what way are an apple and a pear alike?"). The answers are scored according to a standardized rubric with a maximum total score of 26. Higher scores on this task are indicative of greater capacity for verbal reasoning.

***Matrix Reasoning*.** The Matrix Reasoning task (Wechseler, 2008) is a standardized neuropsychological subtest of the perceptual reasoning index of the Wechsler's Adult Intelligence Scale (WAIS-IV) and is designed to assess reasoning involving visuospatial stimuli. The participant is asked to view an incomplete matrix and select a response option (from available alternatives) that best completes the matrix.

Trail Making Test (TMT). The TMT (Delis, Kaplan, & Kramer, 2001) is a timed paper and pen task designed to assess executive function skills including sustained attention, sequencing and, in particular, cognitive flexibility. Participants are required to locate, and then draw connecting lines between, numbers and letters in an alternating sequence as quickly and as accurately as possible. Participants' completion time and performance accuracy are recorded.

MHI Status and Demographic Information

***Brock University Neuropsychology Cognitive Research Laboratory Everyday Living Questionnaire*.** This questionnaire was designed to assess the participant's demographic, lifestyle and health status with a particular emphasis on obtaining a detailed history of the nature

of any reported head injury. Our definition of head injury was adapted from Kay et al. (1993) and is described as “any trauma to the head sufficient to produce an altered state of consciousness, e.g., dizziness, confusion, "seeing stars”. The questionnaire included several items addressing the nature of injury, time since injury, nature of symptoms, and duration of symptoms.

Procedure

Individuals were invited to participate in a study examining personality and social decision making in university students, and received research credit for their participation. Participants were tested individually in a single session in the Lifespan Development Research test facilities at Brock University. Completion of this study took a period of 2 hours and entailed 3 phases. During the first phase, after providing informed consent, participants were fitted with the polygraph equipment and baseline equipment checks were completed. Once the participant was comfortable with the test setting, a 3-minute baseline measure of EDA and HR was recorded. The emotional processing task (EPT) protocol was then described to the participant and s/he was advised that physiological measures would be taken throughout. Participants were seated approximately 60 cm in front of a 22” computer screen and completed the EPT (described previously). On each trial of the EPT, participants were presented an image (either Neutral or Negative, depending on the random sequence that they received) for 8 seconds, followed by four different rating scales (T1). They were to indicate their rating using the computer mouse during which both their rating and time to respond were recorded. The same image was then immediately presented a second time, but this time it was accompanied by a written statement that either confirmed the valence of the picture (confirmed context – i.e., providing a comment

that reaffirmed a negative event or neutral description) or provided a contextual change allowing the reinterpretation of the valence of the image (altered context – i.e., providing a negative context to an otherwise neutral picture, or a neutralizing context to an otherwise emotionally provocative/negative image), which again was followed by the four rating scales (T2). In total 24 pictures were presented (6 in each of the picture valence by confirming/disconfirming context conditions), and the order of conditions was randomly presented. Following the EPT task, a post-task 3-minute recording was taken, after which the physiological equipment was removed.

During Phase 2 of the study, the administration order of the tests was held constant: Similarities, Matrix Reasoning, followed by the Trail Making Test. The researcher sat directly opposite the participant and recorded the participants' verbal responses on a sheet hidden from the participants' view. Prior to beginning Phase 2, participants were reassured that their performance on the tasks would be kept confidential and was in no way a measure of their "intelligence"; they were reminded that these tasks were designed to become increasingly complex and difficult to complete. When unsure, participants were asked to "make their best guess" or simply indicate that they "did not know".

During Phase 3, participants completed a battery of questionnaires (also with order held constant): the empathy (QCAE), psychopathy (SRP-III) and, finally, the demographic questionnaire. Following the completion of the questionnaires, participants were asked to verbally confirm their reports of any incidence injury reported. Upon receiving confirmation, a detailed interview was conducted by the researcher to clarify the nature, biomechanics and frequency of injury. Participants were thanked for their time and participation in the study and were invited to view the results of the study upon its completion.

Data Analyses

Statistical Tests. SPSS 22.0 (SPSS, Chicago, Illinois, USA) was used to analyze all data pertaining to this study. In order to examine effects of participants' Head Injury (No MHI, MHI) and Psychopathy status (lower, higher) on the primary dependent variables of interest (EPT ratings, physiological measures of arousal, QCAE scores, and performance on the cognitive tasks) mixed model ANCOVAs were employed. Findings were considered to be significant with $p \leq .05$; however, trends approaching significance, i.e., $p < .10$, and patterns of observed means and bi-variate relationships are also discussed. Due to the unequal distribution of the female subjects across groups based on Head Injury/Psychopathy classification, analyses were conducted on the total sample as well as the male subsample; separate analyses for females were not possible (see Table 2), Gender was used as a co-variate in all primary analyses (i.e., total sample). Note that all effects were also confirmed within the male cohort, where the distribution across groups was relatively equal. Since the general pattern of results did not change, these results are not described in detail with only the key points being emphasized. Any significant interactions were examined using univariate ANCOVAs (Gender as a covariate)/ANOVAs. Considering the exploratory nature of the study and the subtlety of the hypothesized effects, adjustments were not made for multiple analyses. Hierarchical multiple regression analyses were conducted to examine the effects of severity of injury (Severity Index) which were examined after controlling for the effects of gender, and psychopathy scores (entered as a continuous variable).

Note that all relevant assumptions of the statistical techniques employed have been examined[2] and can be assumed to be met unless noted otherwise. In lieu of any violations of assumptions of the tests employed, post-hoc analyses were conducted using conservative non-parametric procedures, specifically the Mann-Whitney Test, the Kruskal-Wallis Test and the Spearman's rho coefficient, as deemed appropriate.

Results

Participant Characteristics

MHI & Personality. As a measure of assessing personality differences, psychopathy scores were examined as a function of head injury status ($M_{No\ MHI}$ = 150.59, *SE* = 2.90; M_{MHI} = 152.79, *SE* = 3.94). Overall, participants did not differ as a function of Head Injury on global psychopathy scores, F (1, 97) = .19, $p > .05$, $\eta_p^2 = .002$. Interestingly, upon examining scores on factors of psychopathy (primary, secondary) as a function of head injury status, a significant main effect of SRP factor, $F^{G\text{-}G}$ (1, 97) = 22.15, $p = .001$, $\eta_p^2 = .19$, as well as an interaction

[2] Assumptions of Normality (via Histograms, P-P Plots, Box-plots), Homogeneity of Error Variances (via Levene's Test), Sphericity (via Mauchly's Test), & Homogeneity of Covariance Matrices (via Box's M Test) were examined for Analysis of Variance Tests. Assumptions of Linearity (via scatterplots, residual partial plots), Homoscedasticity (via residual plots), Independence of Residuals (via Index Plots, Durbin Watson Test), & Normality of Residuals (via Histograms, P-P Plots) were examined for Multiple regression analyses. Predictors (Gender, Psychopathy, Injury Severity) were checked for multicollinearity (via Tolerance and VIF values). As suggested by Cohen, Cohen, West & Aiken (2003), errant cases/outliers were checked for leverage (via Mahalanobis distance scores), discrepancy (via studentized residual scores) and global influence (via DFFITS scores). Any influential cases that exceeded the accepted cut-off values and/or significantly altered the significance of results were excluded from the analysis.

between SRP factor and Head Injury, $F^{G\text{-}G}$ (1, 97) = 5.09, p = .026, η_p^2 = .05[3], was found. Overall, scores were higher on the primary factor of the SRP than on the secondary factor ($M_{Primary}$ = 80.56, SE = 1.30 vs. $M_{Secondary}$ = 71.13, SE = 1.38), but the interaction resulted from a smaller difference between primary and secondary factor scores for the MHI group compared to the no-MHI group. Indeed, when comparing the groups on each factor separately, while no significant difference between MHI groups was found on the primary factor ($M_{No\ MHI}$ = 81.48, SE = 1.58 vs. M_{MHI} = 79.63, SE = 2.15)), the MHI group scored significantly higher than the no-MHI group on the secondary factor of psychopathy ($M_{No\ MHI}$ = 69.11, SE = 1.69 vs. M_{MHI} = 73.15, SE = 2.29) which indicates endorsement of greater risk-taking behaviour by these subjects. Interestingly, the Callous Affect subscale of the primary factor accounted for 28% of the variance in scores on the secondary factor [r = .67, p < .001; F(1, 33) = 14.81, p = .001] over and above Gender [r = .45, p = .003; ΔR^2 = .21, F(1, 34) = 8.83, p = .005] for the MHI group. In contrast, it accounted for only 3% of the variance in scores on the secondary factor [r = .34, p = .003; F(1, 61) = 3.06, p = .085] over Gender [r = .36, p = .002; ΔR^2 = .13, F(1,62) = 9.01, p = .004] for the No MHI group (see Figure 3). Participants' average scores on the different sub-scales of the SRP-III as a function of MHI are displayed in Figure 4. Injury Severity was associated with higher scores on Psychopathy, particularly Secondary Psychopathy (Table 6), but was not found to be significantly predictive of higher psychopathy scores over and above the effects of Gender.

[3] *Note*. The Box's M test of equality of covariance matrices was violated (p < .05) due to which Greenhouse-Geisser$^{G\text{-}G}$ corrections were used.

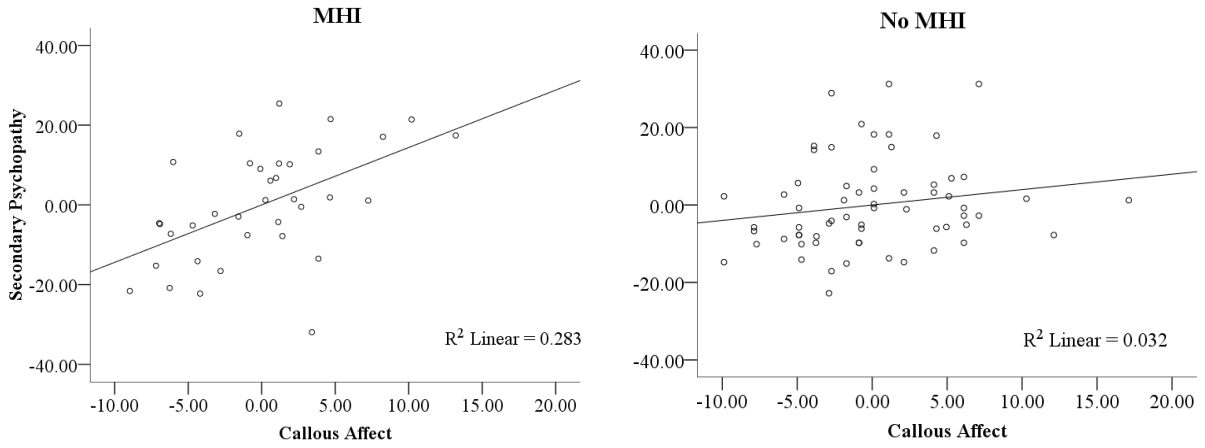

Figure 3. Scatterplots of residuals against predicted values with Callous Affect predicting Secondary Psychopathy in MHI (n = 36) and No MHI (n = 64) groups respectively.

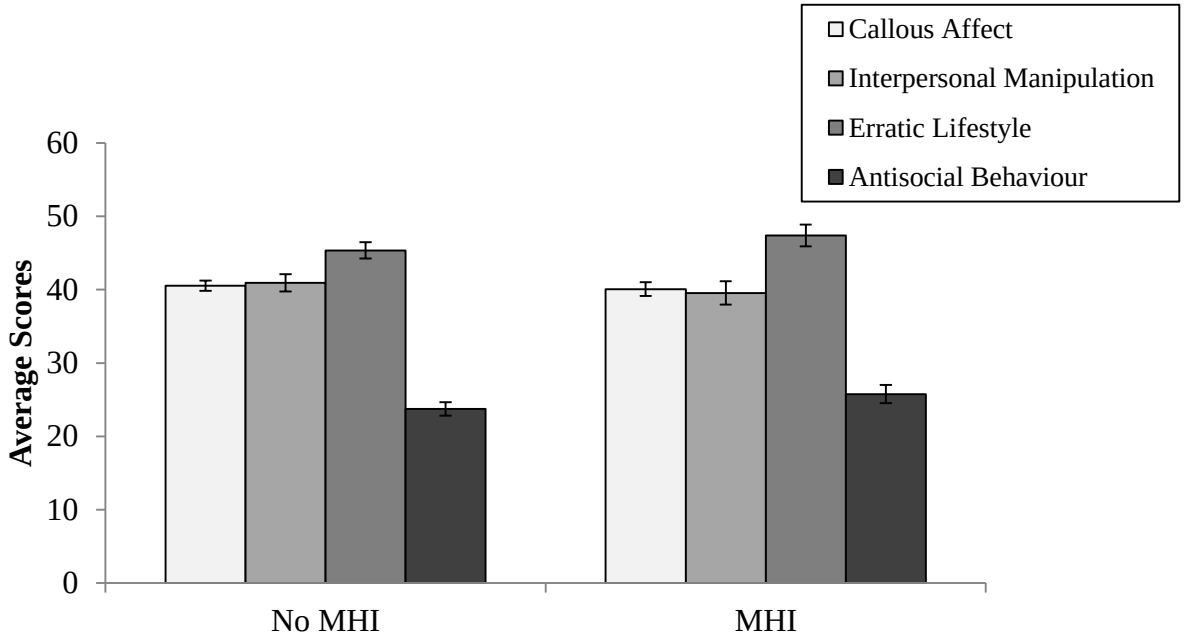

Figure 4. Average scores on the subscales of the Self Report Psychopathy Scale (SRP-III) by Head Injury status (No MHI, MHI). Means are adjusted for Gender. Error bars represent standard errors.

Table 6

Correlations between Injury Severity and the Factors of the Self Report Psychopathy Scale (SRP III)

SRP III	Severity Index r	*p* (two-tailed)
Primary Psychopathy	.16	.122
Callous Affect	.19	**.060**
Interpersonal Manipulation	.10	.312
Secondary Psychopathy	.26	**.010**
Erratic Lifestyle	.20	**.051**
Antisocial Behaviour	.25	**.011**
Total SRP Score	.23	**.023**

Note. N = 100; r = Pearson correlation coefficient.

As another indicator of risk-taking, participants' engagement in recreational alcohol and drug use was examined as a function of Head Injury (No MHI, MHI). Based on information collected from the demographic questionnaire, a measure of recreational risk-taking (RRI) was created using the number of alcoholic drinks consumed per week along with engagement in recreational drug use. The MHI group reported greater substance use than the No MHI group ($M_{No\ MHI}$ = 3.20, SE = .82 vs. M_{MHI} = 6.88, SE = 1.13), F (1, 96) = 6.56, p = .01, η_p^2 = .06, over and above any effects of Gender, consistent with their pattern of responding on the secondary factor

of psychopathy[4]. Interestingly, this result was moderated by psychopathy, such that the main effect of Head Injury, F (1, 94) = 9.6, p = .003, η_p^2 = .09; Psychopathy, F (1, 94) = 4.3, p = .04, η_p^2 = .04; and their Interaction, F (1, 94) = 5.6, p = .02, η_p^2 = .06, were significant. MHI participants with higher psychopathy scores reported greater recreational substance use than those with lower psychopathy scores and both of these groups reported greater use than No MHI subjects, who did not differ as a function of psychopathy (Figure 5)[5]. Moreover, Injury severity was found to be predictive of greater scores on the RRI (r = .33, p < .001), accounting for 4.4% of unique variance over and above the effect of Gender and Psychopathy [F(1, 95) = 5.53, p = .021].

[4] *Note.* The index of risk-taking (RRI) was significantly associated with the secondary factor of psychopathy [r = .38, p < .001; ΔR^2 = .047; F(1, 96) = 5.84, p = .018] of which the erratic lifestyle subscale emerged as the best predictor of scores on the index uniquely accounting for 6% of the variance [r = .395, p < .001; t = 2.78, p = .007].

[5] Note that the Levene's Test of Homogeneity of Error Variances was significant (p < .05). Consequently, the observed effects were confirmed via Mann-Whitney tests which yielded significant main effects for Head Injury (p = .03) and Psychopathy (p = .001). Moreover, while participants were found to differ as a function of psychopathy in the MHI group (p = .019), the effect of psychopathy was not significant in the No MHI group (p = .093).

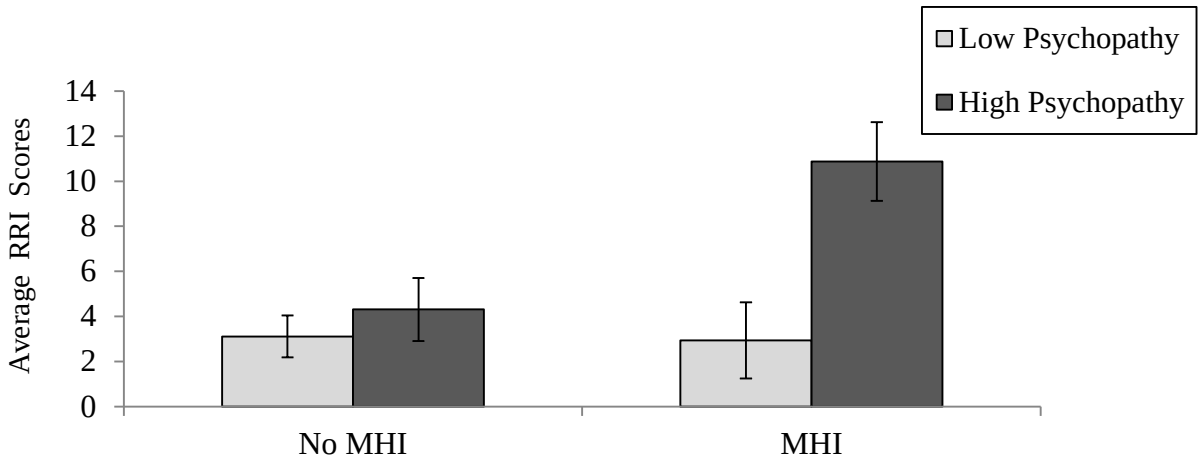

Figure 5. Average scores on the recreational index of risk-taking (RRI) as a function of participants' Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) classification. Error bars represent standard errors. *Note*. RRI = Recreational Risk Index based on participants report of recreational alcohol and drug use with higher scores indicative of greater risk taking.

Main Findings

Affective Empathy: Behavioural Ratings on Trial 1

Empathy. In order to examine group differences in affective empathy, participants' empathy ratings at Trial 1 of the EPT were examined. A mixed model 2 x 2 x 2 repeated measures ANCOVA was conducted with Image Type (Neutral, Negative) as a within-subjects factor, and Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) as between-subjects factors. Participants' Gender (Female, Male) was entered as a covariate[6].

While no main effect of Gender emerged, $F(1, 95) = 0.53$, $p > .05$, $\eta_p^2 = .006$, Gender was found to interact with Image Type, $F(1, 95) = 4.55$, $p = .036$, $\eta_p^2 = .05$, indicating that men and women differed on their ratings of empathy for Negative images ($M_M = 7.12$, $SE = .17$; $M_F =$

[6] The effect of psychopathy was confirmed with a hierarchical regression analyses where Gender was entered in Step 1 of the model, followed by average total psychopathy scores entered in Step 2.

7.63, *SE* = .16), but not Neutral images (M_M = 3.59, *SE* = .18, M_F = 3.20, *SE* = .17)[7]. Overall, the effect of Psychopathy was significant, $F(1, 95) = 4.03$, $p = .048$, $\eta_p^2 = .04$, such that individuals with higher psychopathy scores (*M* = 5.09, *SE* = .18) displayed overall reduced empathy relative to those with lower scores (*M* = 5.52, *SE* = .12)[8]. No main effect of Head Injury was observed, $F(1, 95) = 1.62$, $p > .05$, $\eta_p^2 = .02$, nor was there a significant interaction between Head Injury and Psychopathy, $F(1, 95) = 2.16$, $p > .05$, $\eta_p^2 = .02$; however, the MHI-HP group produced the lowest empathy ratings, particularly for Negative images[9]. The reader is referred to Figure 6 for a visual depiction of this data.

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[7] The interaction between Gender and Image Type was also significant within the No MHI LP (baseline) group, $F(1, 48) = 8.55$, $p = .005$, $\eta_p^2 = .15$, with the same pattern of means as the primary analysis.

[8] Results from the hierarchical regression analysis confirmed the effect of Psychopathy which emerged as a significant predictor [Total $R^2 = .11$, $\Delta R^2 = .044$, $F(1, 97) = 4.63$, $p = .034$] of empathy ratings over and above Gender [$\Delta R^2 = .046$, $F(1, 98) = 4.70$, $p = .033$, $\beta = -.21$, $r = -.21$, $p = .016$]. Based on the direction of the relationship [$\beta = -.24$; $r = -.29$, $p = .002$], higher psychopathy scores were predictive of lower empathy ratings and uniquely accounted for 4.6% of the total variance. Interestingly, when examined separately as a function of Head Injury; the effect of Psychopathy was significant only within the MHI group; such that higher psychopathy was predictive of lower empathy ratings for Negative images and accounted for 19% of the total variance [$F(1, 32) = 8.00$, $p = .008$; $\beta = -.52$, $r = -.44$, $p = .004$] over and above Gender which accounted for 2% of the variance. In contrast, Psychopathy accounted for no variance in the No MHI group [$F(1, 60) = .09$, $p = .77$; $\beta = -.04$, $r = -.15$, $p = .13$] where Gender emerged as the best predictor [$F(1, 62) = 3.52$, $p = .065$; $\beta = -.23$, $r = -.23$, $p = .033$] uniquely accounting for 5.4% of the variance, such that males displayed lower empathy ratings while viewing Negative images. Interestingly, additional analyses found the callous affect subscale of psychopathy to be the best predictor of reduced empathy in the MHI cohort [$r = -.47$, $p < .01$; $\Delta R^2 = .09$; $t = -1.96$, $p = .06$] relative to the other subscales ($p > .05$).

[9] The same pattern of results was maintained within the male cohort. While the effects did not yield statistically significant differences, the effect sizes for the main effect of Psychopathy, $F(1, 43) = 2.59$, $p > .05$, $\eta_p^2 = .06$, and the interaction between Head Injury and Psychopathy, $F(1, 43) = 1.86$, $p > .05$, $\eta_p^2 = .04$, increased relative to the primary analysis. Further, results from the regression analysis found Psychopathy to be a significant predictor ($p = .031$) of empathy ratings ($r = -.32$, $p = .016$), uniquely accounting for 9.9% of the total variance. When examined based on Head Injury status, the effect of Psychopathy was confined to the MHI [$r = -.48$, $p = .007$; $\Delta R^2 = .23$; $F(1, 23) = 7.03$, $p = .014$] versus the No MHI group [$r = -.05$, $p = .420$; $\Delta R^2 = .00$; $F(1, 20)$

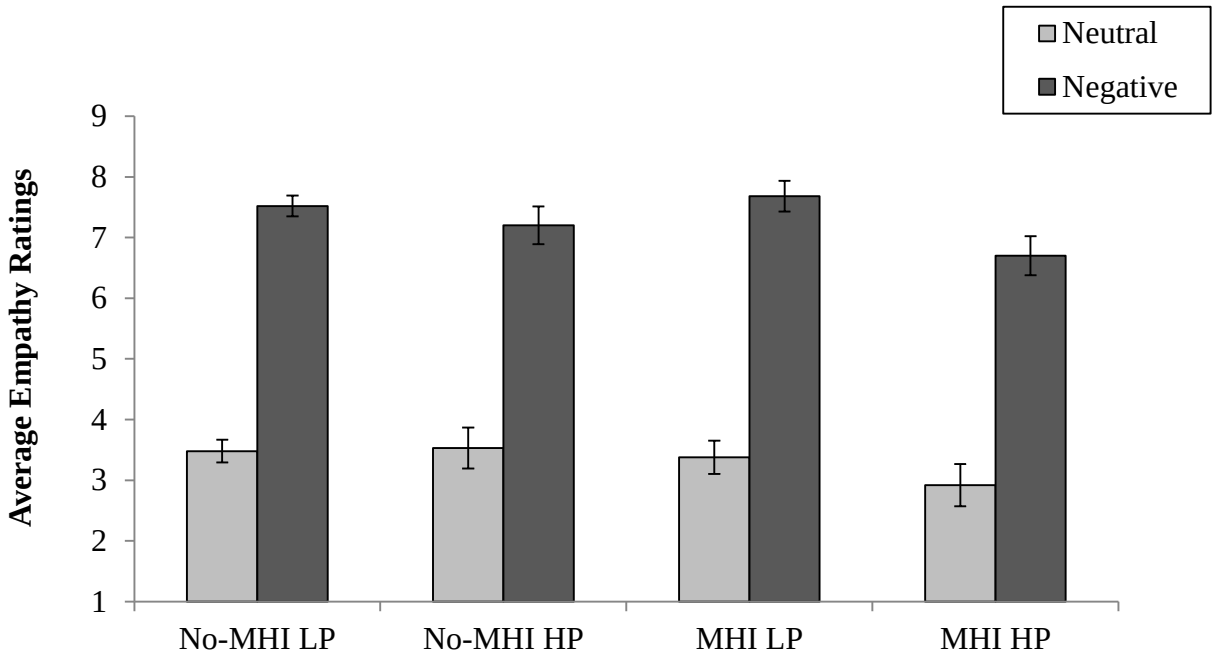

Figure 6. Average empathy ratings on Trial 1 of the EPT as a function of participants' Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) classification. Error bars represent standard errors.

T1 Empathy Ratings as a Function of Injury Severity. Hierarchical regression analyses were conducted to examine the effect of Injury Severity in predicting empathy ratings while participants viewed images on Trial 1 of the EPT. To partial out the effect of Gender, it was entered in Step 1 of the model. Total Psychopathy scores were entered in Step 2, and the Injury Severity Index was entered in Step 3. The inter-correlation between predictors is presented in Table 7.

= .04, p = .84]; with callous affect emerging as the best predictor of reduced empathy within the former [sr^2 = .123; t = -1.89, p = .073

Table 7

Inter-correlations between predictors: Gender, Psychopathy & Severity Index

Predictors	Gender	Psychopathy	Severity Index
Gender	1.00	.51***	.26**
Psychopathy	-	1.00	.23*
Severity Index	-	-	1.00

Note. N = 100; considering the significant relationships between the predictors, a check for multicollinearity via Tolerance and Variance Inflation Factor (VIF) values was conducted, and found to be within the acceptable range; ***$p < .001$, **$p < .01$, *$p < .05$.

Results from the regression analysis (Table 8) found Injury Severity to be predictive of reduced overall empathy (see Figure 7) accounting for 6% additional variance over and above Gender and Psychopathy [$F(1, 95) = 5.82$, $p = .018$] [10, 11]. The effect of Injury Severity was found to be more pronounced for Negative images relative to Neutral Images. Within the MHI cohort, Injury severity accounted for 11% of the variance in empathy ratings for Negative images [$\beta = -.33$; $F(1, 31) = 5.10$, $p = .03$] [12], but only 4% of the variance in empathy ratings with Neutral images [$\beta = -.19$, $F(1, 31) = 1.11$, $p = .300$][13] (Figure 8). Note that while Psychopathy was

[10] *Note*. Current findings exclude Participant 164 who was found to be a significant outlier on the severity index.

[11] The same pattern was maintained in the male cohort with Injury severity predictive of reduced overall empathy [$F(1, 43) = 5.26$, $p = .027$], accounting for 10% of additional variance over and above psychopathy [$F(1, 44) = 4.54$, $p = .039$].

[12] When examined in the male cohort, although significantly correlated ($r = -.24$, $p = .05$), Injury Severity was not found to be significantly predictive of empathy ratings for Negative images [Total $R^2 = .16$, $\Delta R^2 = .039$, $\beta = -.20$, $F(1, 43) = 1.99$, $p = .166$]; but uniquely accounted for 4% of the total variance in the criterion.

[13] When examined in the male cohort, Injury severity significantly correlated with Neutral empathy ratings (r = -.28, p = .029) and emerged as a marginally significant predictor [Total $R^2 = .084$, $\Delta R^2 = .072$, $\beta = -.27$, $F(1,43) = 3.38$, $p = .073$] accounting for 7.2% variance; greater Injury Severity was predictive of lower empathy ratings for Neutral images, over and above

associated with reduced overall empathy [r = -.18, p = .037; F(1, 96) = 3.17, p = .074], it was a significant predictor of reduced empathy only while viewing Negative images [r = -.30, p = .001; F(1, 96) = 5.13, p = .026][14].

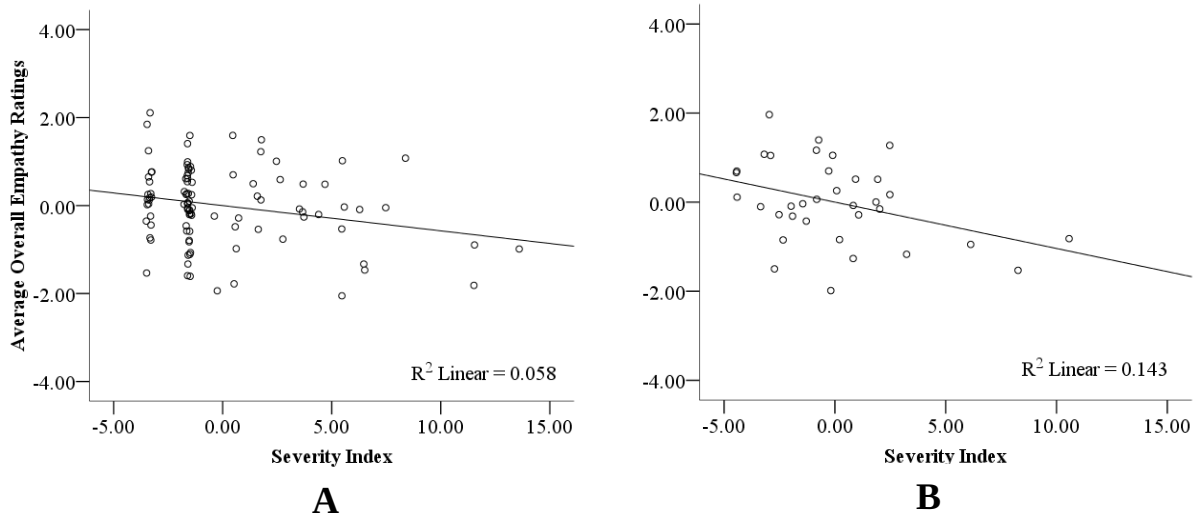

Figure 7. Scatterplots of residuals against predicted values depicting participants' overall empathy ratings on Trial 1 as a function of Injury Severity (Severity Index). **A.** Includes all subjects[a] (N = 99). **B.** Includes MHI subjects[a] only (n = 35). *Note.*[a] Case 164 was excluded as it was a significant outlier.

Psychopathy [r = -.11, p = .23; ΔR^2 = .012, β = -.11, F(1, 44) = .54, p = .466]. *Note*. The findings described exclude Participant 164 due to being a significant outlier.

[14] The same pattern of results was maintained in the male cohort with Psychopathy uniquely accounting for 10% of the total variance, with higher scores predictive of lower empathy ratings while viewing Negative images [r = -.34, p = .01; ΔR^2 = .12, β = -.31, F(1, 44) = 5.82, p = .02].

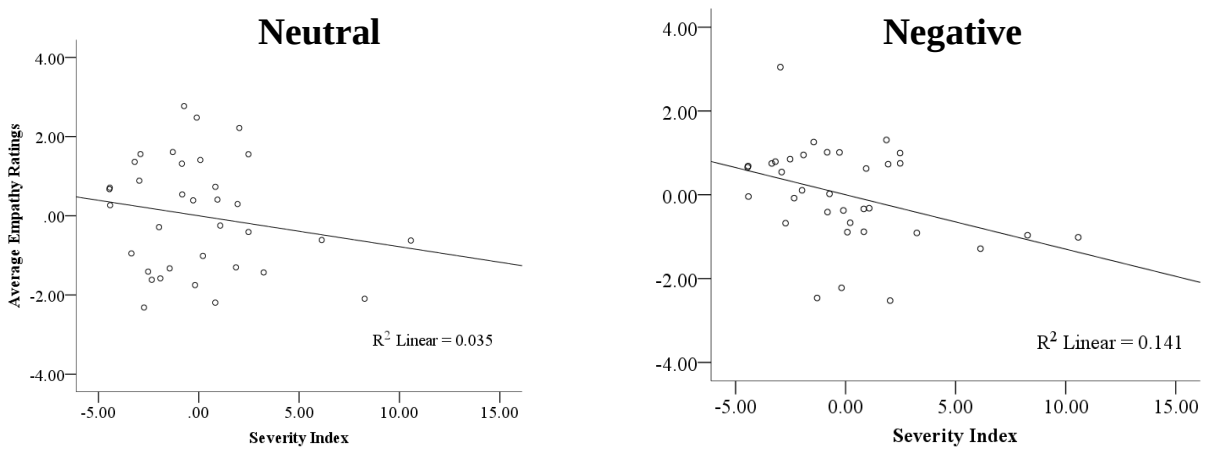

Figure 8. Scatterplots of residuals against predicted values depicting participants' Empathy ratings for Neutral and Negative images as a function of Injury Severity (Severity Index) within the MHI cohort[a] (*n* = 35). *Note.*[a] Case 164 was excluded as it was a significant outlier.

Arousal. The same analyses as described above were conducted on the arousal ratings. The ANCOVA indicated no overall effect of Gender, $F(1, 95) = 1.18$, $p > .05$, $\eta_p^2 = .01$; however, the interaction between Image Type and Gender produced a marginally significant effect, $F(1, 95) = 3.55$, $p = .063$, $\eta_p^2 = .04$, indicating that men and women tended to differ on their ratings of arousal such that females rated negative images ($M_F = 6.21$, $SE = .30$; $M_M = 5.20$, $SE = .32$), but not neutral images ($M_F = 2.96$, $SE = .17$; $M_M = 3.02$, $SE = .18$), as more arousing[15].

The main effect of Head Injury was found to be marginally significant, $F(1, 95) = 3.16$, $p = .079$, $\eta_p^2 = .03$, with MHI individuals reporting overall reduced arousal relative to the No MHI

[15] The same pattern of responding was observed in the No-MHI LP (baseline) group, ($M_F = 6.23$, $SE = .33$; $M_M = 5.46$, $SE = .56$), $F(1,48)= 3.22$, $p = .079$, $\eta_p^2 = .063$.

group ($M_{No\ MHI}$ = 4.69, *SE* = .23; M_{MHI} = 4.05, *SE* = .27). Unlike their ratings on empathy, no effect of Psychopathy emerged, $F(1, 95) = 0.13$, $p > .05$, $\eta_p^2 = .001$[16], nor was there an interaction between Head Injury and Psychopathy, $F(1, 95) = 1.63$, $p > .05$, $\eta_p^2 = .02$. Based on the pattern of means, individuals reporting a Head Injury who also scored higher on Psychopathy presented with overall lower arousal ratings, particularly for Negative images[17]. The reader is referred to Figure 9 for a visual depiction of these findings.

[16] This was confirmed in the regression analysis where the effect of Psychopathy was not significant [$\Delta R^2 = .01$; $F(1,97) = 1.08$, $p = .301$] over and above Gender [$\Delta R^2 = .05$; $F(1, 98) = 5.18$, $p = .025$]. Interestingly, albeit not significant; psychopathy was found to be a better predictor in the MHI [r = -.28, $p = .05$; $\Delta R^2 = .04$, $F(1, 33) = 1.45$, $p = .24$] versus the No MHI group [r = -.08, $p = .27$; $\Delta R^2 = .00$, $F(1, 61) = .01$, $p = .92$] respectively accounting for 4% vs. 0% variability in Negative arousal ratings[16]. Exploratory analyses indicated that while scores on the callous affect subscale of psychopathy was the best predictor of reduced arousal ratings in both groups; it was a better predictor in the MHI group accounting for 12% [r = -.44, $p = .004$; $t = -2.14$, $p = .04$] of unique variance versus 6% in the No MHI group [r = -.25, $p = .022$; $t = -1.94$, $p = .057$].

[17] When examined in the male cohort, the same overall pattern of responding was preserved. While the main effect of Head Injury did not yield significant results, $F(1, 43) = 1.91$, $p > .05$, $\eta_p^2 = .04$, the effect size increased relative to the primary analysis with means in the expected direction ($M_{No\ MHI}$ = 4.50, *SE* = .36; M_{MHI} = 3.83, *SE* = .33). Results from the confirmatory regression analysis found the effect of Psychopathy to be marginally significant for Negative images in the MHI group [r = -.36, $p = .038$; $\Delta R^2 = .13$; $F(1,23) = 3.47$, $p = .075$], versus the No MHI group [r = -.008, $p = .485$; $\Delta R^2 = .00$; $F(1,20) = .00$, $p = .97$]; with callous affect being the best predictor of reduced arousal ratings for negative images in the MHI group [r = -.45, $p = .012$; $sr^2 = .075$; $t = -1.41$, $p = .17$].

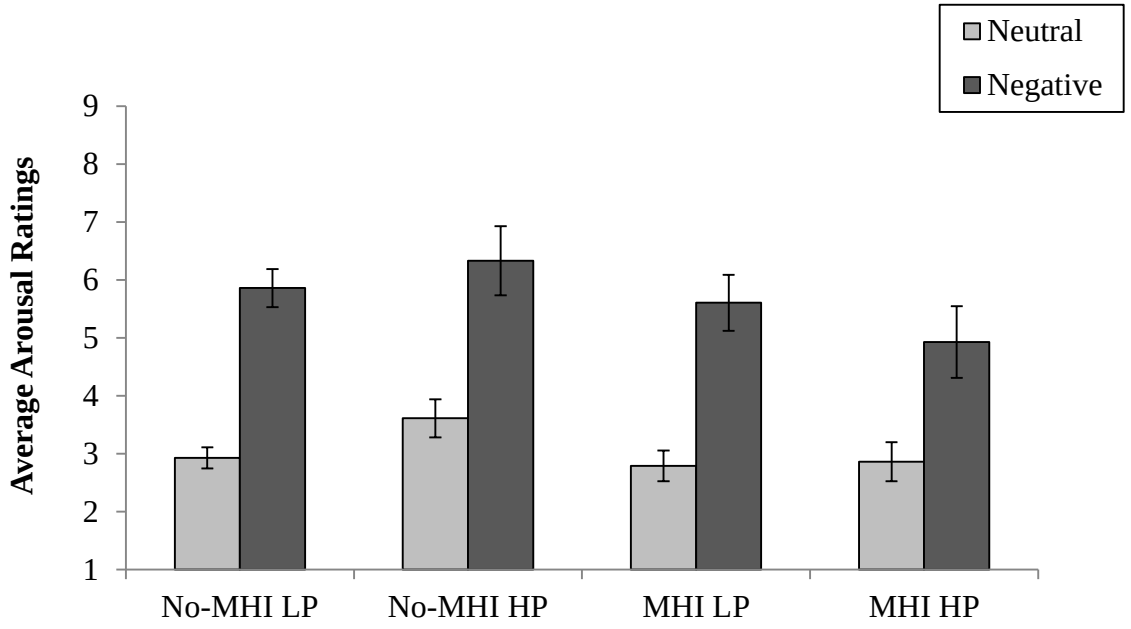

Figure 9. Average arousal ratings on Trial 1 of the EPT as a function of participants' Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) classification. Error bars represent standard errors.

T1 Arousal Ratings as a Function of Injury Severity. As hypothesized, Injury severity was found to be predictive of lower overall arousal ratings (see Figure 10) and accounted for 7% additional variance over and above Gender and Psychopathy [F (1, 96) = 7.15, p = .009][18] (Table 9). This was found to be particularly pronounced for Negative images. Within the MHI cohort, Injury severity accounted 18% variance in arousal for Negative images [β = -.44, F (1, 32) =

[18] When examined in the male cohort, the effect of injury severity strengthened and accounted for 15% additional variance in overall arousal [F (1, 44) = 8.09, p = .007] over and above Psychopathy [F (1, 45) = 1.29, p = .263].

7.97, $p = .008$] [19,20], but only 4% of the variance in arousal for Neutral images [$\beta = -.20$, F (1, 32) = 1.24, $p = .275$] [21,22] (Figure 11).

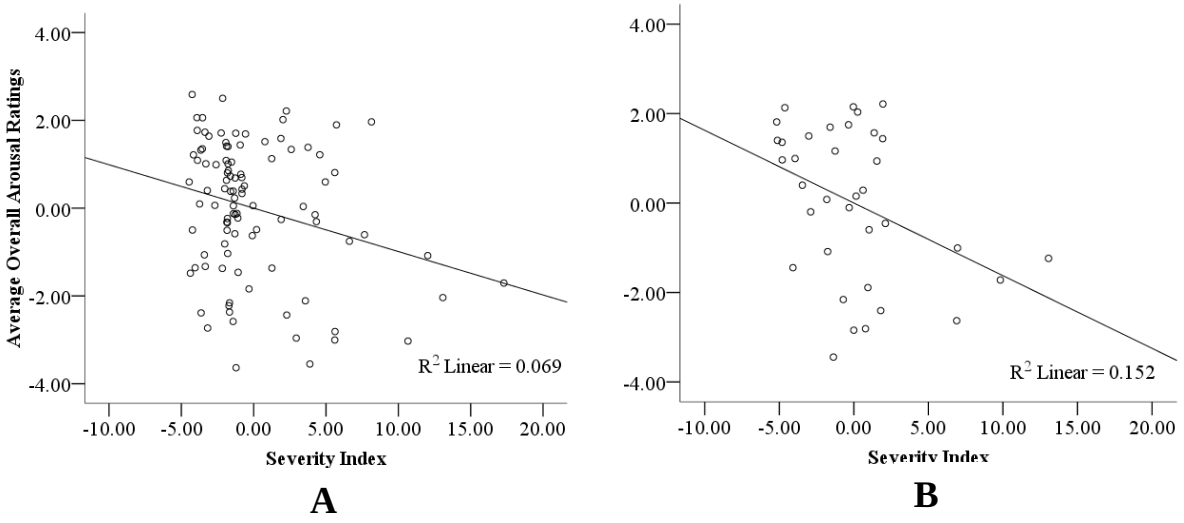

Figure 10. Scatterplots of residuals against predicted values depicting participants' overall arousal ratings for images viewed on Trial 1 of the EPT as a function of Injury Severity (Severity Index). **A.** Includes all subjects (N = 100). **B.** Includes MHI subjects only (n = 36).

[19] Participant 164 was not found to be significantly influential (based on their DFFITS values) for arousal ratings and retained in the analyses. Although attenuated, exclusion of Participant 164 did not affect the significance, with Injury Severity accounting for 5.3% of the variance [r = -.28, $p = .003$; F (1, 95) = 5.62, $p = .02$].

[20] When examined in the male cohort, Injury Severity accounted for 15% variability over and above Psychopathy [r = -.44, $p = .001$; F(1, 44) = 8.41, $p = .006$]. Although attenuated, exclusion of Participant 164 did not affect the significance of results, with Injury Severity accounting for 12.5% of the variance [r = -.38, $p = .005$; F(1, 43) = 6.41, $p = .015$].

[21] *Note.* Participant 164 was not found to be significantly influential (based on his DFFITS values) for arousal ratings and retained in the analysis. However, exclusion of Participant 164 strengthened the effect of Injury Severity as a predictor; accounting for 3% of the total variance [r = -.16, $p = .06$; F (1, 95) = 2.85, $p = .095$].

[22] When examined in the male cohort, Injury Severity significantly correlated with Neutral arousal ratings (r = -.27, $p = .037$) and accounted for 8% total variance, such that greater Injury Severity was predictive of lower arousal ratings while viewing Neutral images [F (1, 44) = 3.88, $p = .055$]. Of note, exclusion of 164 strengthens the effect of Injury Severity as a predictor, accounting for 12% of the total variance [r = -.35, $p = .009$; F (1, 43) = 6.10, $p = .018$].

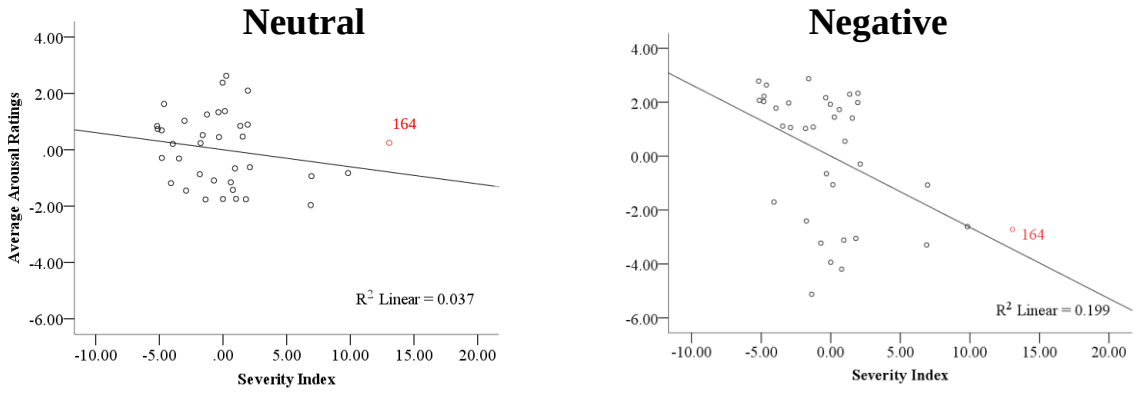

Figure 11. Scatterplots of residuals against predicted values depicting participants' Arousal ratings for Neutral and Negative images as a function of Injury Severity (Severity Index) within the MHI cohort (n = 36). Influential cases are highlighted.

Intensity. No main effect of Gender, Psychopathy or Head injury was obtained for the measure of Intensity. However, the interaction between Head Injury and Psychopathy was found to be marginally significant, $F(1, 95) = 3.29$, $p = .07$, $\eta_p^2 = .033$. Interestingly, follow-up analyses found participants' intensity ratings to differ as a function of Psychopathy only within the MHI group, $F_{Image\ Type\ X\ SRP}\ (1, 33) = 3.21$, $p = .08$, $\eta_p^2 = .09$; such that those with higher psychopathy displayed lower intensity ratings particularly while viewing Negative ($M_{MHI\ LP} = 7.33$, $SE = .28$; $M_{MHI\ HP} = 6.22$, $SE = .34$) versus Neutral images ($M_{MHI\ LP} = 2.98$, $SE = .27$; $M_{MHI\ HP} = 2.83$, SE

=.33). No effects of Psychopathy were observed within the No MHI group[23][24]. Participants' average Intensity ratings while viewing images on T1 of the EPT as a function of their Head Injury by Psychopathy status are displayed in Figure 12.

[23] Consistent with the primary analysis, results from the confirmatory regression analyses found the effect of Psychopathy to be confined only to the MHI group [r = -.37, p = .014; Total R^2 = .27, ΔR^2 = .16, β = -.49, F(1, 32) = 7.12, p = .012]; versus the No MHI group [r = -.12, p = .18; Total R^2 = .09, ΔR^2 = .00, β = -.02, F(1, 60) = .03, p = .87] with Psychopathy accounting for 16% versus 0% variability respectively. Exploratory analyses found the callous affect subscale of psychopathy to be the best predictor of reduced intensity in the MHI cohort [r = -.46, p < .01; sr^2 = .11 t = -2.07, p = .05] relative to the other subscales (p > .05).

[24]When examined in the male cohort, the Head Injury by Psychopathy interaction was significant, F(1, 43) = 4.59, p = .038, η_p^2 = .096. Follow up tests found the effect of Psychopathy to be significant only within the MHI group with higher psychopathy associated with overall lower Intensity ratings ($M_{MHI\ LP}$ = 5.29, SE = .28; $M_{MHI\ HP}$ = 4.52, SE = .25), F(1, 23) = 4.24, p = .05, η_p^2 = .156. Results from the confirmatory regression analysis found the effect of Psychopathy to be confined to the MHI [r = -.45, p = .003; ΔR^2 = .20; F(1, 23) = 5.73, p = .025] versus the No MHI group [r = .07, p = .375 ; ΔR^2 = .01; F(1, 20) = .11, p = .750] while viewing Negative images; with callous affect emerging as the best predictor of reduced intensity within the MHI group [sr^2 = .072; t = -1.43, p = .170].

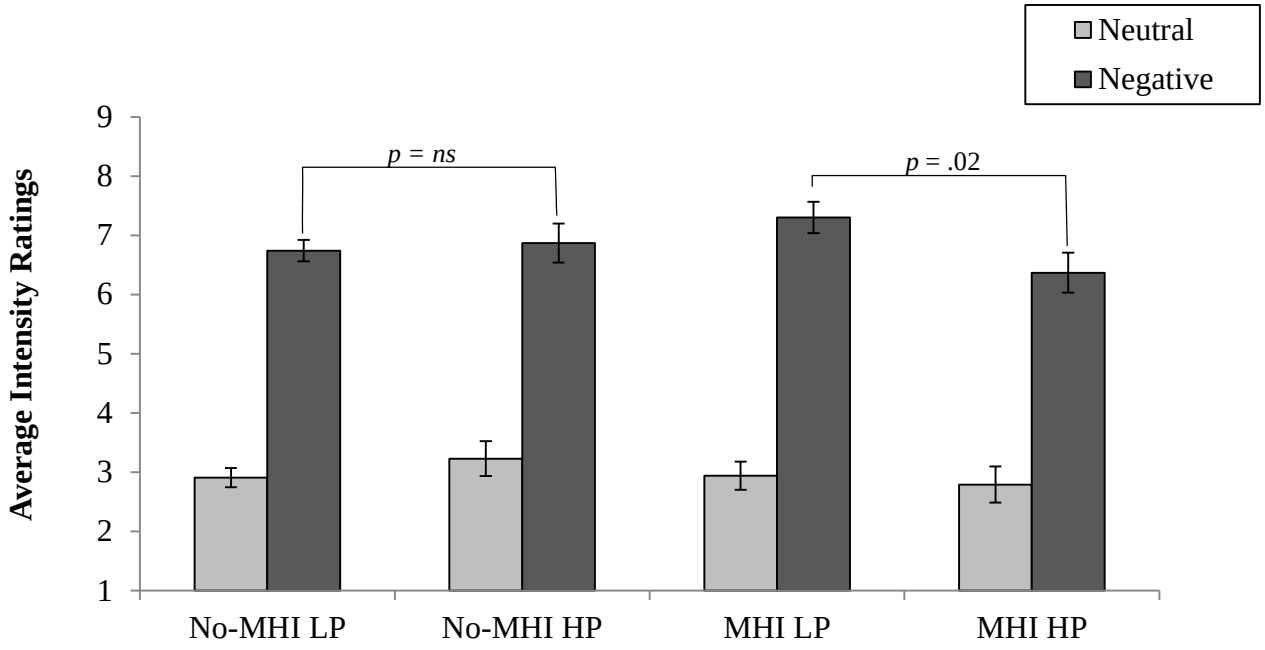

Figure 12. Average intensity ratings on Trial 1 of the EPT as a function of participants' Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) classification. Error bars represent standard errors. *Note*. *ns* = not significant.

TI Intensity Ratings and Injury Severity. No significant effects of Injury Severity emerged for Intensity ratings while viewing images on Trial 1 of the EPT[25]. The summary of results is presented in Table 10.

[25] When examined within the male cohort, a negative correlation was observed between Injury Severity and overall intensity ratings (r = -.24, p = .054) such that greater Injury Severity was associated with lower intensity ratings, and accounted for 4% variance over and above psychopathy [β = -.20, F(1, 44) = 1.83, p = .182]. However due to a high incidence of influential cases, the reader is advised to exercise discretion in the interpretation of these findings.

Pleasantness[26]. No main effect of Gender, Psychopathy or Head injury was obtained for the measure of Pleasantness[27,28]. Participants' average pleasantness ratings based on their Head Injury by Psychopathy status are displayed in Figure 13.

[26] *Note*. The data was found to be significantly skewed and violated the assumption of normality. Consequently, all effects were confirmed using non-parametric tests (Mann-Whitney U), w3ere no group differences were significant as a function of Gender, Psychopathy or Head Injury ($p > .05$).

[27] Results from the confirmatory regression analysis found the effect of Psychopathy to be significant for Negative images [r = .23, p = .012, Spearman's rho = .22, p = .028; Total R^2 = .053, ΔR^2 = .043, β = .24, $F(1, 95) = 4.27$, p = .042]. Psychopathy accounted for 4% of the variance with higher psychopathy scores predictive of higher pleasantness ratings (i.e., more "Neutral" ratings) for Negative images viewed in Trial 1. When examined separately based on Head Injury status, the effect of Psychopathy was particularly pronounced in the MHI group [r = .25, p = .07, Spearman's rho = .16, p = .37; Total R^2 = .14, ΔR^2 = .12, β = .42, $F(1, 32) = 4.38$, p = .044] versus the No MHI group [r = .21, p = .05, Spearman's rho = .27, p = .03; Total R^2 = .064, ΔR^2 = .019, β = .17, $F(1, 60) = 1.18$, p = .28], with Psychopathy accounting for 12% versus 2% of the variance respectively. Although not significant, as with the other behavioural measures, the callous affect subscale of psychopathy emerged as the best predictor of higher ratings of pleasantness while viewing Negative images, accounting for 7% of unique variance in the MHI group [r = .32, p = .027; t = 1.65, p = .109][27].

[28] The same pattern of results was maintained within the male cohort. The effect of Psychopathy was confined to the MHI [r = .30, p = .075; ΔR^2 = .09; $F(1, 22) = 2.23$, p = .149] versus the No MHI group [r = -.08, p = .360 ; ΔR^2 = .01; $F(1, 19) = .13$, p = .719]; with callous affect emerging as the best predictor of higher pleasantness ratings within the MHI group [sr^2 = .18; t = 2.12, p = .048].

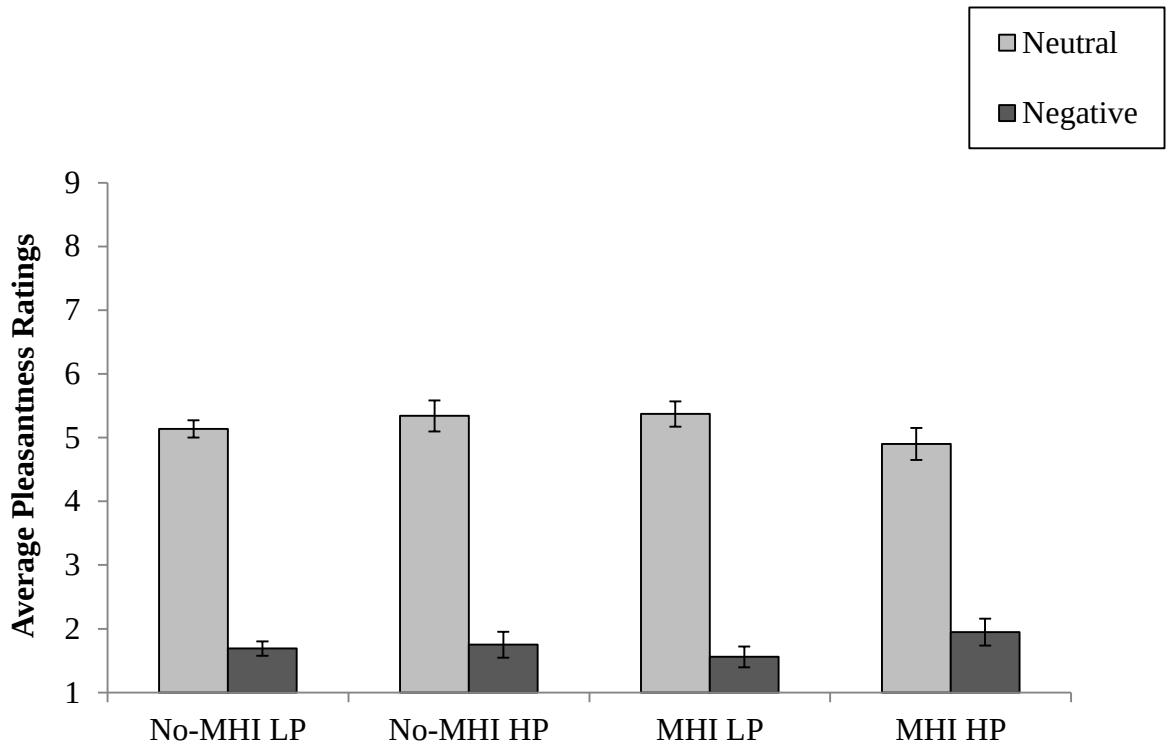

Figure 13. Average pleasantness ratings on Trial 1 of the EPT as a function of participants' Head Injury (No MHI, MHI) and Psychopathy (Lower, Higher) classification. Error bars represent standard errors. *Note.* Based on the nature of the pleasantness scale (1 = *unpleasant*, 5 = *neutral*, 9 = *pleasant*), lower values is indicative of a more "unpleasant" response and higher values is indicative of a more "neutral" response.

TI Pleasantness Ratings and Injury Severity. No significant effects of Injury Severity emerged for Pleasantness ratings while viewing images on Trial 1 of the EPT[29]. The summary of results is presented in Table 11.

[29] When examined within the male cohort, a negative correlation was observed between Injury Severity and Neutral pleasantness ratings (r = -.25, p = .046) such that greater Injury Severity was associated with lower pleasantness ratings for Neutral images, and accounted for 5.5% variance over psychopathy [$F(1, 44) = 2.57$, p = .116]. However due to a high incidence of influential cases and non-normality in data, the reader is advised to exercise discretion in the interpretation of these findings. No effect of Injury Severity emerged for pleasantness ratings for Negative images [r = -.07, p = .312, ΔR^2 = .01, $F(1, 44) = .26$, p = .611].

Cognitive Empathy: Behavioural Ratings on Trial 2

In order to examine aspects of cognitive empathy, change in ratings from Trial 1 (i.e., ratings after passive viewing) to Trial 2 (i.e., ratings after a context is provided) was examined. Change scores were calculated by subtracting T1 ratings from their corresponding T2 ratings. A 2 x 2 x 2 x 2 mixed model repeated measures ANCOVA was conducted on the change scores with Image Type (Neutral, Negative) and Context (Confirming, Contrasting) as within-subjects factors (producing participants' change scores across four conditions, namely: Neutral confirming [Neutral-Neutral], Neutral contrasting [Neutral-Negative], Negative confirming [Negative-Negative] and Negative contrasting [Negative-Neutral] conditions). Head injury (No MHI, MHI) and Psychopathy (Lower, Higher) were entered as between-subjects factors. Participants' Gender (Female, Male) was entered as a co-variate.

Empathy Change Scores. A significant interaction between Gender and Image Type, $F(1, 95) = 3.81$, $p = .054$, $\eta_p^2 = .04$, revealed that females displayed less of a change for Negative images ($M_M = -1.24$, $SE = .14$; $M_F = -1.69$, $SE = .13$), while no group differences (Males, Females) were observed for Neutral images ($M_M = 1.44$, $SE = .12$; $M_F = 1.63$, $SE = .13$). Psychopathy interacted with Context, $F(1, 95) = 3.76$, $p = .055$, $\eta_p^2 = .04$, such that individuals higher on Psychopathy produced less of a change in empathy ratings for contrasting trials relative to those with lower psychopathy ($M_{LP}= -.07$, $SE = .13$; $M_{HP}= -.39$, $SE = .19$). Follow-up univariate tests for the contrasting conditions revealed that this context effect was restricted to the neutral contrast (i.e., Neutral-Negative) condition, $F (1, 97) = 3.46$, $p = .066$, $\eta_p^2 = .03$,

demonstrating reduced cognitive empathy for those with higher psychopathy[30,31]. No significant differences were observed between groups for the negative contrast (i.e., Negative-Neutral) condition, F (1, 97) = .13, $p > .05$, $\eta_p^2 = .00$. The mean change scores for empathy ratings as a function of Psychopathy are displayed in Figure 14.

[30] Examination of T2 empathy ratings revealed significant effects of psychopathy both as a main effect, $F(1, 95) = 4.14$, $p = .045$, $\eta_p^2 = .04$, and an interaction with Context, $F(1, 95) = 5.16$, $p = .025$, $\eta_p^2 = .05$. Individuals higher on psychopathy produced lower empathy ratings ($M = 5.10$, $SE = .19$), particularly when there was a change in context (i.e., contrasting). Follow-up univariate tests for the contrasting conditions revealed that this context effect was restricted to the neutral contrast (i.e., Neutral-Negative) condition, F (1, 97) = 5.16, $p = .025$, $\eta_p^2 = .05$, such that providing a negative context for a previously-rated neutral image produced increased empathy ratings for low psychopathy subjects. This was confirmed in the regression analysis such that psychopathy emerged as a marginally significant predictor ($p = .077$) of empathy ratings in the Neutral-Negative condition. Based on the direction of the relationship (r = -.18, $p = .033$), higher psychopathy scores were associated with lower empathy ratings. Psychopathy did not emerge as a significant predictor ($p > .05$) for empathy ratings in the Negative-Neutral condition.

[31] Although significantly correlated (r = -.22, $p = .013$), psychopathy scores (continuous) did not emerge as a significant predictor of empathy change scores for the Neutral-Negative trials, Adjusted $R^2 = .44$, $\Delta R^2 = .02$, $F(1, 97) = 1.77$, $p = .19$. However, when examined based on Head Injury status, Psychopathy was predictive of reduced change scores for the Neutral-Negative condition [$\Delta R^2 = .089$; $F(1, 33) = 3.59$, $p = .067$] over Gender [$\Delta R^2 = .093$; $F(1, 34) = 3.50$, $p = .070$] only in the MHI group; in contrast, Psychopathy [$\Delta R^2 = .00$; $F(1, 61) = .015$, $p = .902$] accounted for no variance in scores over Gender [$\Delta R^2 = .04$; $F(1, 62) = 2.37$, $p = .129$] in the No MHI group.

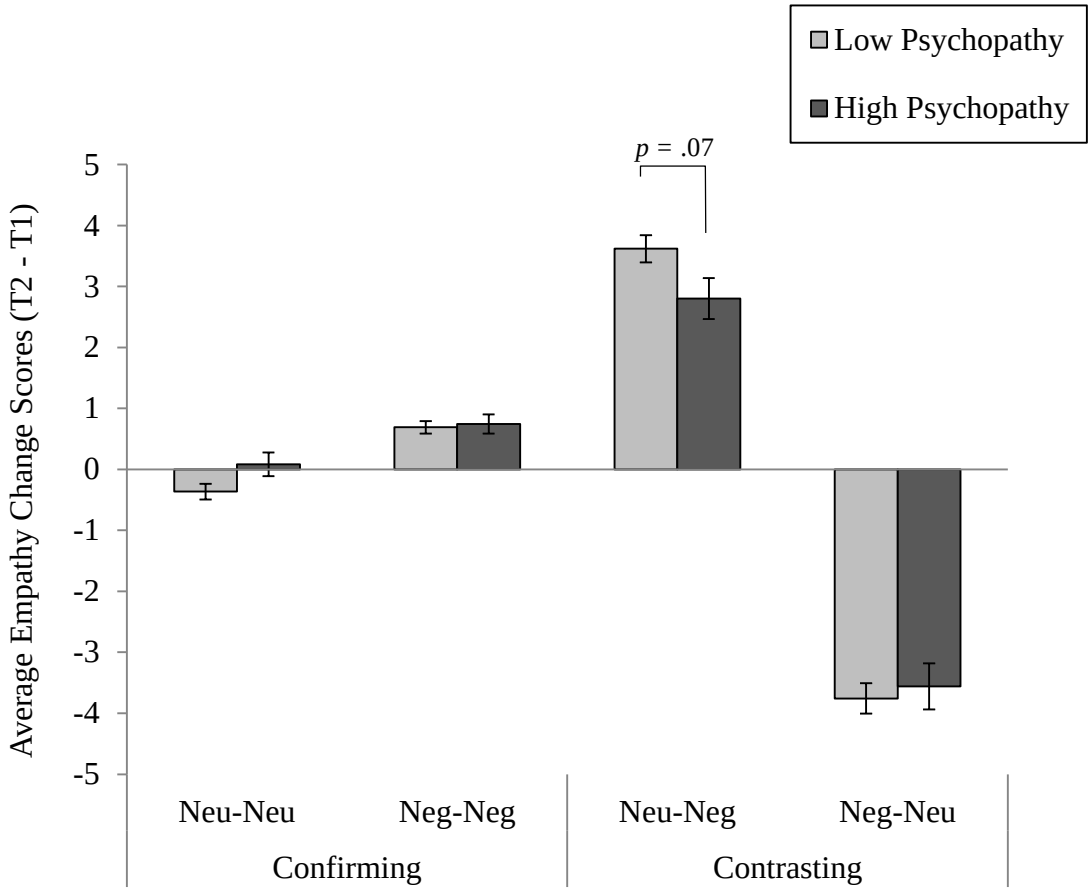

Figure 14. Average empathy change scores based on participants' Psychopathy classification (Lower, Higher). T1 = Trial 1; T2 = Trial 2. Means are adjusted for gender. Error bars represent standard errors.

No effects of Head Injury $F(1, 95) = 0.10$, $p > .05$, $\eta_p^2 = .00$; or Head Injury by Psychopathy $F(1, 95) = 0.01$, $p > .05$, $\eta_p^2 = .00$, emerged. Based on the pattern of observed means, the MHI LP group appeared to display greater change scores (consistent with the intended manipulations), particularly for the contrasting trials relative to the other groups and

hence displayed greater sensitivity to the contextual information provided[32,33]. The average empathy change scores across conditions as a function of participants' Head injury by Psychopathy status are displayed in Figure 15.

[32] In fact, post-hoc exploratory analyses (using *LSD*) contrasting average empathy change scores on Trial 2 across the four groups based on their Head Injury by Psychopathy classification indicated enhanced sensitivity to context for the Neutral-Negative trials in the MHI LP group, particularly relative to those with higher psychopathy i.e., the No MHI HP ($p = .05$) and MHI HP ($p = .09$) groups.

[33] The same pattern of results was confirmed in the male cohort. Although the Psychopathy x Context interaction yielded marginal significance, the effect size was found to increase relative to the primary analysis, $F(1, 43) = 3.21$, $p = .080$, $\eta_p^2 = .07$. Further, based on the pattern of means, the MHI LP group displayed greater change scores for the Neutral-Negative trials (consistent with the intended manipulation) relative to other groups ($M_{No\ MHI\text{-}LP} = 2.90$, $SE = .49$; $M_{No\ MHI\text{-}HP} = 2.78$, $SE = .59$, $M_{MHI\text{-}LP} = 3.27$, $SE = .53$; $M_{MHI\text{-}HP} = 2.74$, $SE = .47$). Although not significant, the results from the regression analysis found Psychopathy to account for greater variance in the MHI group [$\Delta R^2 = .085$; $F(1, 23) = 2.13$, $p = .158$] relative to the No MHI group [$\Delta R^2 = .010$; $F(1, 20) = .21$, $p = .655$] for empathy change scores for the Neutral-Negative condition.

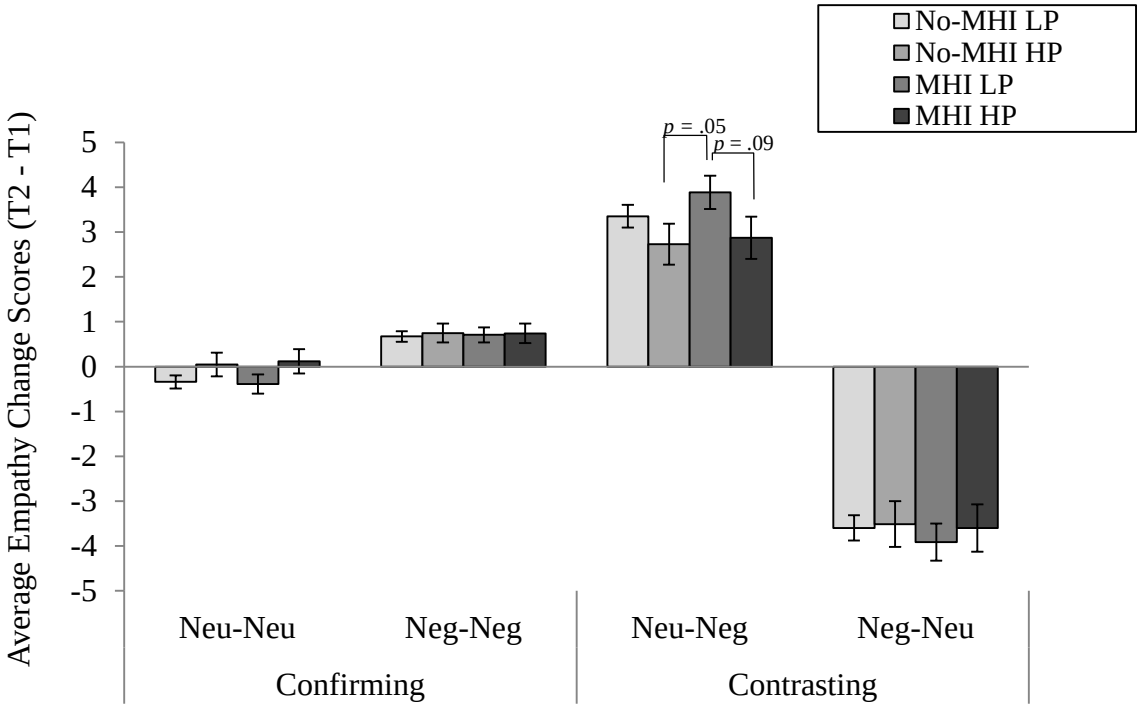

Figure 15. Average empathy change scores based on participants' Head Injury (No MHI, MHI) by Psychopathy (Lower, Higher) classification. T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; LP = Low Psychopathy; HP = High Psychopathy; Neu = Neutral; Neg = Negative. Means are adjusted for gender. Error bars represent standard errors.

Empathy Change Scores and Injury Severity. The summary of results across the different conditions of the EPT is presented in Table 12. Injury severity did not emerge as a significant predictor of empathy change scores for any of the conditions and hence has not been described[34].

***Arousal Change Scores*.** Examination of change scores from T1 arousal ratings found no significant main effects or interactions as a function of Gender, Head Injury[35] and/or

[34] No effects of Injury Severity were significant for empathy change scores within the male cohort.

[35] While no significant effects of Head Injury were observed for arousal change scores, examination of T2 arousal ratings found the main effect of Head Injury to be marginally significant, $F(1, 95) = 3.38$, $p = .069$, $\eta_p^2 = .03$; such that individuals with a head injury appeared to indicate overall lower ratings of arousal ($M = 3.99$, $SE = .28$) relative to the No MHI group (M

Psychopathy[36]. The average change scores as a function group membership based on participants' Head Injury by Psychopathy status are presented in Figure 16. Although not significant, based on the pattern of means individuals scoring higher on Psychopathy (regardless of Head Injury status) displayed relatively lower change scores for the Neutral-Negative trials despite receiving an accompanying negative scenario intended to evoke empathy and heightened arousal[37].

= 4.67, *SE* = .24). A significant interaction between Head Injury and Image Type, $F(1, 95) = 4.31$, $p = .041$, $\eta_p^2 = .04$; revealed that the MHI group displayed lower ratings of arousal for Negative images, $F(1, 95) = 2.86$, $p = .094$, $\eta_p^2 = .03$.

[36] Results from the confirmatory regression analysis found Psychopathy to be a marginally significant predictor ($p = .098$) accounting for 2.7% of the variance in difference scores for the Neutral-Negative condition. The negative relationship between the variables ($r = -.243$, $p = .008$) indicated that higher psychopathy scores were associated with lower change scores in this condition. When examined separately based on Head Injury status, Psychopathy was a significant predictor in the MHI group [$\Delta R^2 = .16$, $F(1, 23) = 4.21$, $p = .052$]; versus the No MHI group [$\Delta R^2 = .01$, $F(1, 20) = .29$, $p = .599$] only in the male cohort. Although not significant, the Callous Affect subscale of Psychopathy proved to be the best predictor of reduced arousal change scores for the Neutral-Negative condition, accounting for 8.2% unique variance within the MHI group of the male cohort [$r = -.42$, $p = .018$; $t = -1.46$, $p = .160$]. No effects were observed for Negative-Neutral trials.

[37] This was confirmed in the male cohort; no significant effects were observed for arousal change scores. However, the overall pattern of means was preserved.

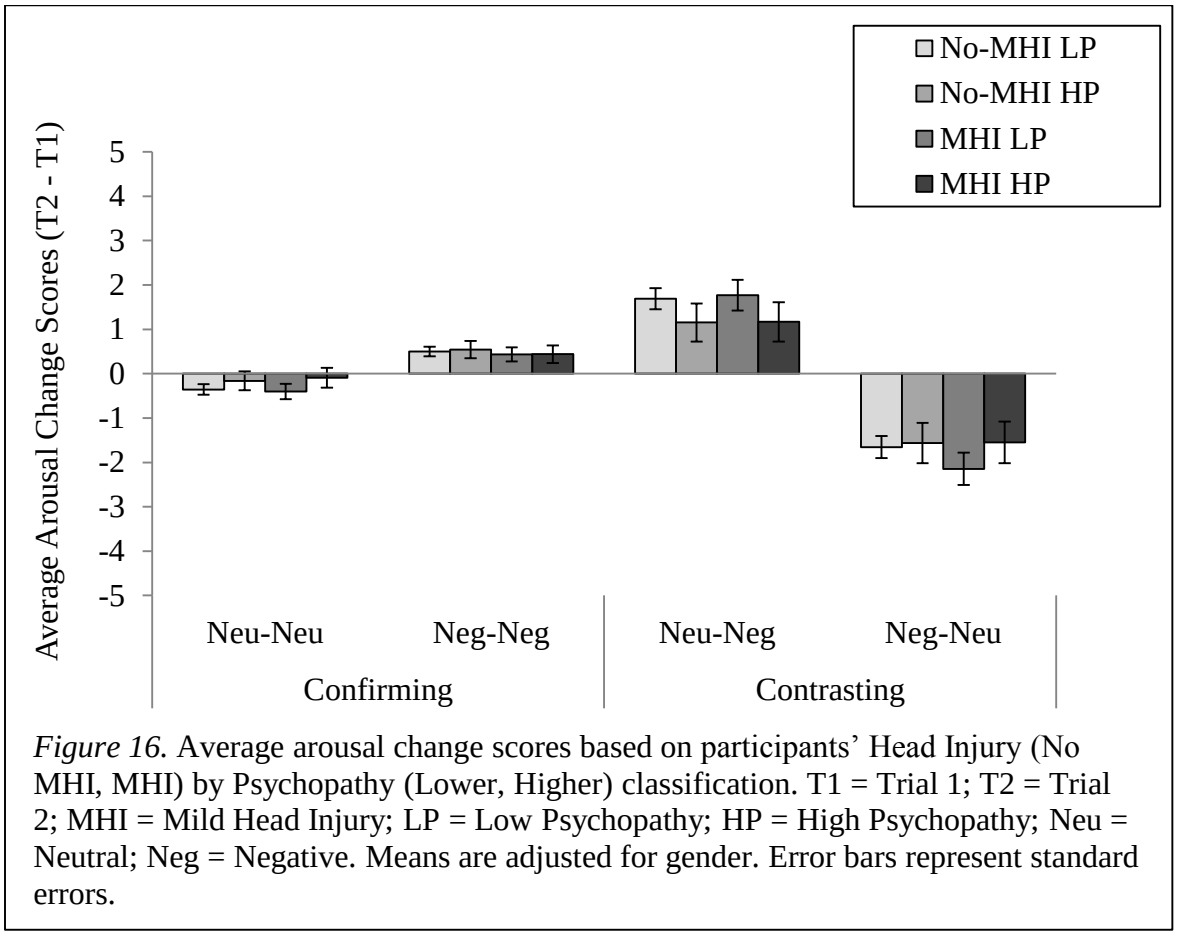

Figure 16. Average arousal change scores based on participants' Head Injury (No MHI, MHI) by Psychopathy (Lower, Higher) classification. T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; LP = Low Psychopathy; HP = High Psychopathy; Neu = Neutral; Neg = Negative. Means are adjusted for gender. Error bars represent standard errors.

Arousal Change Scores and Injury Severity. The summary of results across the different conditions of Trial 2 is presented in Table 13. Effects of Injury Severity emerged only for the neutral contrasting (i.e., the Neutral-Negative) condition. Injury severity (r = -.25, p = .007) significantly correlated with arousal change scores such that greater severity of injury was associated with lower change in arousal ratings, despite receiving a negative scenario (for a previously rated neutral image) intended to evoke heightened emotional responsivity. The overall model was significant [R^2 = .10, $F(3, 96) = 3.62$, p = .016], with injury severity as the only

significant predictor, uniquely accounting for 3.5 percent of the variance (p = .056) [38],[39] (Figure 17). *Note.* Although higher psychopathy was significantly correlated with lower arousal change scores (r = -.24, p = .008), it was not significantly predictive (p = .15) uniquely accounting for 2% of the variance in the criterion, rendering Injury Severity to be a better predictor.

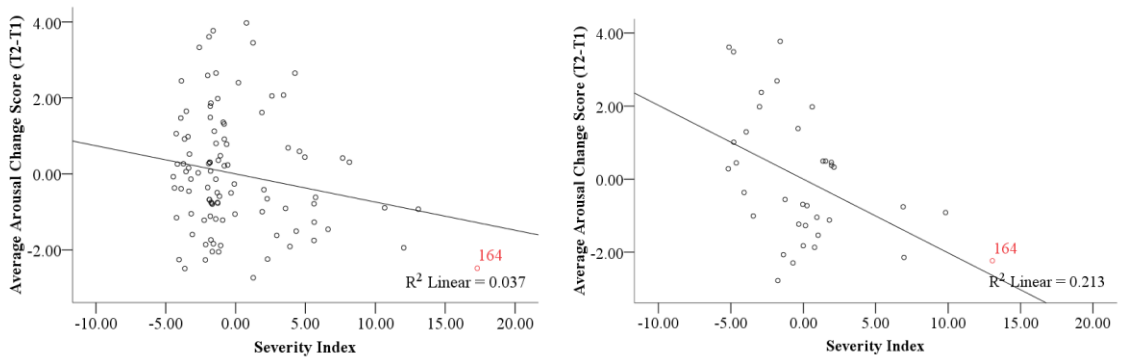

Figure 17. Scatterplots of residuals against predicted values depicting participants' Arousal change scores for Neutral-Negative trials as a function of Injury Severity (Severity Index). **A.** Includes all subjects (N = 100). **B.** Includes MHI subjects only (n = 36). Influential cases are highlighted.

[38] This was reflected in their behavioural ratings, such that greater severity of injury was predictive of lower arousal ratings for the Neutral-Negative trials [r = -.24, p = .007, ΔR^2= .023, F (1, 95) = 3.88, p = .052].

[37] The same pattern of results was observed in the male cohort; injury severity uniquely accounted for 5.1% of the variance in arousal change scores such that greater severity of injury was associated with lower change in arousal ratings for the Neutral-Negative trials [r = -.30, p = .02; F (1, 44) = 2.64, p = .111].

Intensity Change Scores[40]**.** No main effect of Gender or its interactions were significant. A significant interaction between Image Type x Context x Head Injury, $F^{G\text{-}G}(1, 95) = 5.16$, $p = .025$, $\eta_p^2 = .05$[41]; found Head Injury to interact with Context only for the Negative images, $F(1, 97) = 9.75$, $p = .002$, $\eta_p^2 = .09$, such that relative to the No MHI group, MHI individuals produced *greater* change in intensity ratings, particularly for the negative contrasting (i.e., Negative-Neutral) trials[42,43] (Figure 18).

[40] *Note.* Box's M Test of Equality of Covariance Matrices was significant ($p = .008$) due to which Greenhouse-Geisser $^{G\text{-}G}$ corrections were used.

[41] A similar pattern of responding was observed in the male cohort. Head injury was found to interact with context, $F(1, 43) = 2.91$, $p = .095$, $\eta_p^2 = .06$; such that compared to the No MHI group, MHI individuals displayed greater overall change scores for contrasting trials [$M_{MHI} = \left|.27\right|$, $SE = .15$; $M_{No\ MHI} = .05$, $SE = .16$]. Although the interaction only yielded marginal significance, its effect size increased relative to the primary analysis.

[42] Note that Levene's test of Homogeneity of Error Variances was violated ($p = .048$) for the Negative-Neutral trials. However, results were confirmed using non-parametric tests where a significant effect of head injury was observed, Mann-Whitney U = 757.50, $p = .005$.

[43] In fact, examination of T2 intensity ratings confirmed significantly lower intensity ratings for the Negative-Neutral trials in the MHI group, $F(1, 95) = 8.71$, $p = .004$, $\eta_p^2 = .08$, such that provision of a neutralizing context for a previously rated negative image evoked significantly lower intensity in individuals indicating a previous head injury, [$M_{MHI} = 3.83$, $SE = .25$; $M_{No\ MHI} = 4.69$, $SE = .18$].

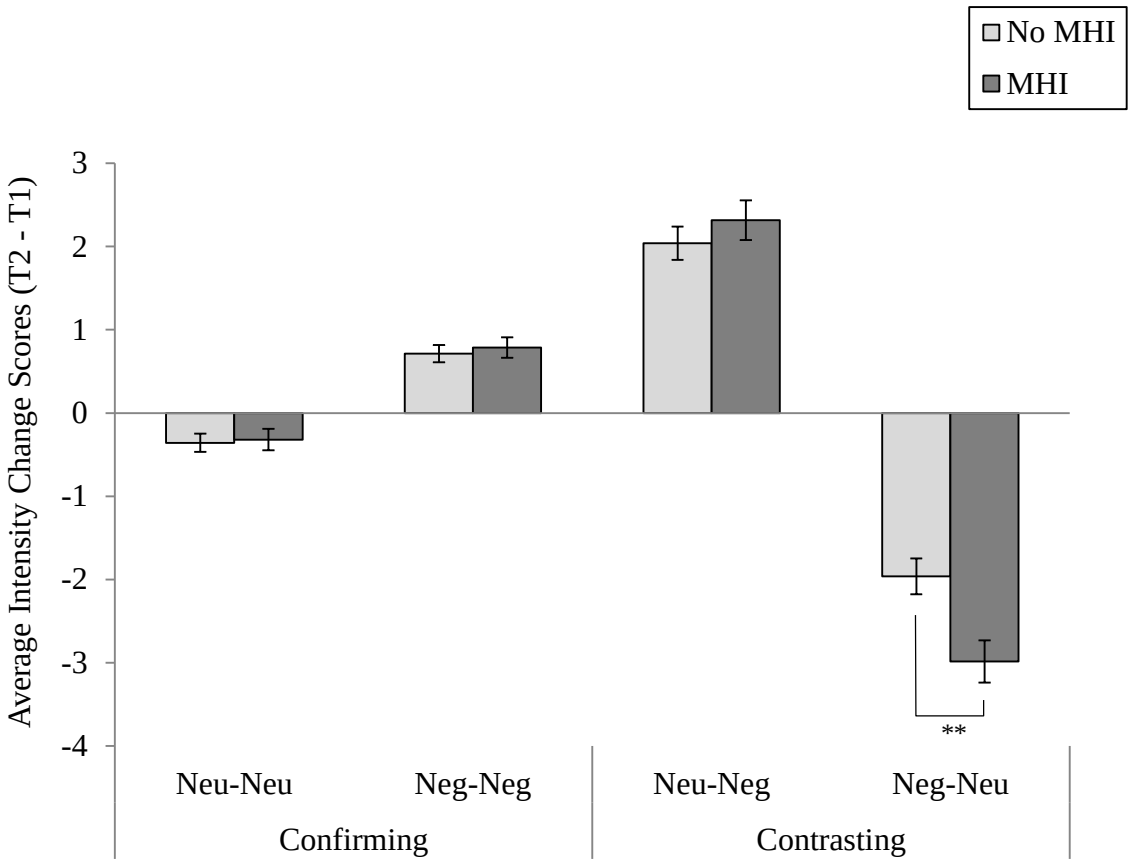

Figure 18. Average intensity change scores based on participants' Head Injury (No MHI, MHI) status. T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; Neu = Neutral; Neg = Negative. Means are adjusted for gender. Error bars represent standard errors.
** $p < .01$

Interestingly, a four-way interaction between Image Type x Context x Psychopathy x Head Injury, $F^{G\text{-}G}(1, 95) = 4.22$, $p = .043$, $\eta_p^2 = .043$[44,45]; revealed *lower* change in intensity

[44] This was confirmed in the regression analysis where the effect of Psychopathy was confined to the MHI group [r = -.49, $p = .001$, $\Delta R^2 = .19$, $F(1, 33) = 8.34$, $p = .007$, versus the No MHI group [r = .025, $p = .423$, $\Delta R^2 = .01$, $F(1, 61) = .33$, $p = .565$] for Neutral-Negative trials.
[45] Although the four-way interaction was not significant in the male cohort, $F(1, 43) = 2.20$, $p = .15$, $\eta_p^2 = .05$, the effect size increased relative to the primary analysis. Interestingly results from the regression analysis based on Head Injury status found higher psychopathy to be associated with *greater* change in intensity ratings for Neutral-Negative trials (r = .35, $p = .055$) in the No MHI group and accounted for 12.2% of the variance in scores [$F(1, 20) = 2.78$, $p = .111$]. In contrast, higher psychopathy within the MHI group was associated with *lower* change scores (r =

ratings for contrasting trials of Neutral images (i.e., Neutral-Negative condition) as a function of Psychopathy only in the MHI group, $F(1, 33) = 4.89$, $p = .034$, $\eta_p^2 = .13$, versus the No MHI group, $F(1, 61) = .10$, $p = .752$, $\eta_p^2 = .00$; such that provision of contrasting contextual information for previously-rated Neutral images evoked lesser change in intensity ratings for those with higher psychopathy only if they had reported a previous head injury (Figure 19).

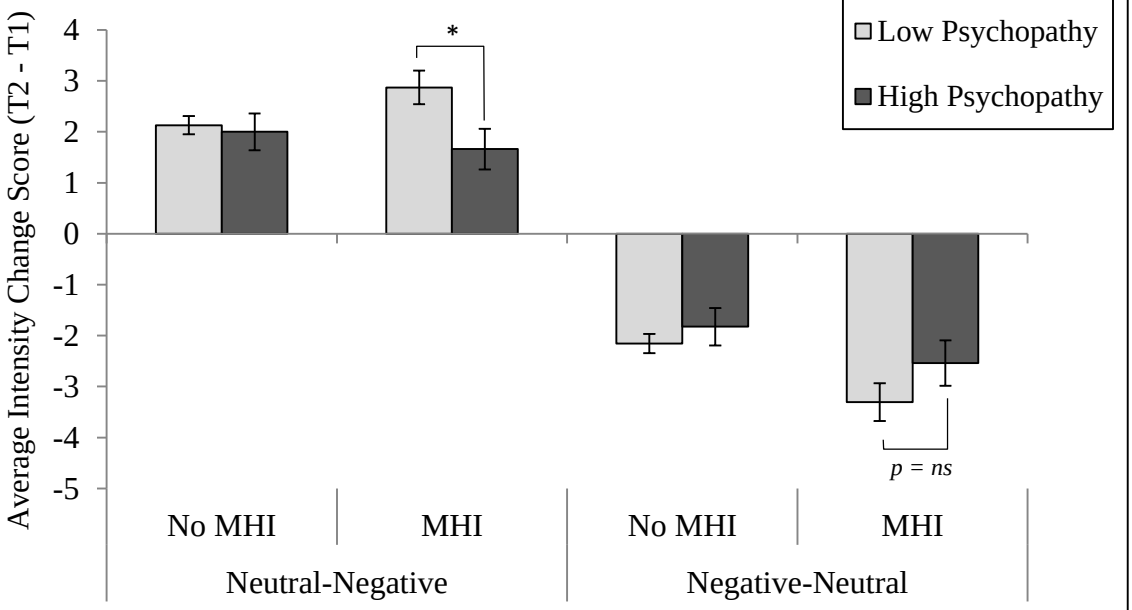

Figure 19. Average change in intensity ratings for the contrasting conditions of Trial 2 of the EPT as a function of Psychopathy (Lower, Higher) based on Head Injury Status (No MHI, MHI). T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; Means are adjusted for Gender. Error bars represent standard errors.
* $p < .05$

Interestingly, exploratory post-hoc analyses indicated the MHI-LP group to display greatest sensitivity to the contextual information provided. They were found to display significantly greater change scores for the contrasting trials, i.e., the Neutral-Negative, $F(3, 95) =$

-.49, $p = .007$) accounting for 23.5% variance. Exploratory analyses found the Interpersonal Manipulation subscale of Psychopathy to emerge as the best predictor of greater change scores in the No-MHI group [r = .45, $p = .019$; $sr^2 = .09$, $t = 1.46$, $p = .160$]; while Antisocial Behaviour [r = -.50, $p = .006$; $sr^2 = .08$, $t = 1.46$, $p = .160$] accounted for greater variance in the MHI group, in male subjects.

2.90, $p = .039$, $\eta_p^2 = .084$; and Negative-Neutral, $F(3, 95) = 5.06$, $p = .003$, $\eta_p^2 = .138$, conditions (in the expected direction) relative to all other groups[46]. The average change scores across conditions by group membership are illustrated in Figure 20.

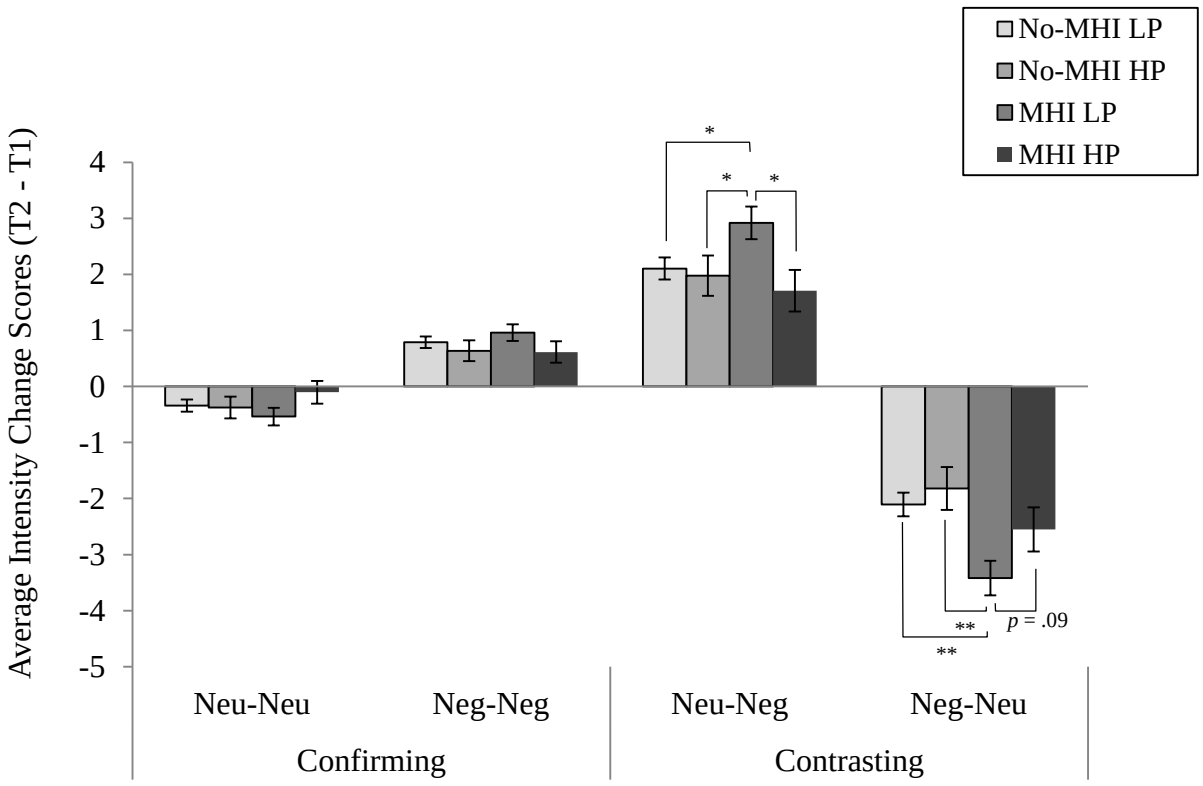

Figure 20. Average change in intensity ratings for confirming and contrasting conditions of Trial 2 of the EPT based on participants' Head Injury (No MHI, MHI) by Psychopathy (Lower, Higher) classification. T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; LP = Low Psychopathy; HP = High Psychopathy; Neu = Neutral; Neg = Negative. Means are adjusted for gender. Error bars represent standard errors.
* $p < .05$, ** $p < .01$

[46] Although not significant, based on the pattern of means, the MHI LP group displayed greater change (in the expected direction) for the contrasting conditions i.e., the Neutral-Negative [$M_{No\ MHI\ LP} = 1.72$, $SE = .38$; $M_{No\ MHI\ HP} = 2.27$, $SE = .45$; $M_{MHI\ LP} = 2.74$, $SE = .41$; $M_{MHI\ HP} = 1.66$, $SE = .36$] and Negative-Neutral trials [$M_{No\ MHI\ LP} = -1.90$, $SE = .43$; $M_{No\ MHI\ HP} = -1.88$, $SE = .51$; $M_{MHI\ LP} = -2.93$, $SE = .46$; $M_{MHI\ HP} = 2.52$, $SE = .41$] relative to the other groups.

Intensity Change Scores and Injury Severity. The summary of results across the different conditions of Trial 2 is presented in Table 14. Effects of Injury Severity emerged only for the negative contrasting (i.e., the Negative-Neutral) condition. Injury severity correlated with intensity change scores (r = .17, p = .043) such that greater severity of injury was found to be predictive of higher change in intensity ratings, demonstrating greater sensitivity to the contextual information provided[47]. The negative relation between Psychopathy and the criterion indicated lower psychopathy scores to be predictive of higher change scores demonstrating reduced sensitivity to the contextual information in those with higher psychopathy[48,49].

Pleasantness Change Scores. No main effect of Gender or its interactions were significant. A significant interaction between Image Type x Context x Psychopathy, $F(1, 95) = 7.33$, $p = .01$, $\eta_p^2 = .072$[50], revealed that individuals scoring higher on psychopathy displayed

[47] In fact, upon examining T2 intensity ratings, severity of injury was associated with significantly lower intensity ratings for the negative contrasting trials (r = -.23, p = .01), in line with the contextual information provided [$\Delta R^2 = .052$, $F(1, 95) = 6.77$, p = .01]. The effect of psychopathy was not significant [$\Delta R^2 = .019$, p = .11].

[48] When examined separately based on Head Injury status, although Psychopathy accounted for greater variance in the MHI group [r = -.34, p = .020; $\Delta R^2 = .059$, $F(1, 33) = 2.22$, p = .145], the effect of Psychopathy was maintained for the No MHI group [r = -.23, p = .036; $\Delta R^2 = .04$, $F(1, 61) = 2.59$, p = .113], with higher psychopathy associated with lower change in intensity ratings for Negative-Neutral trials.

[49] When examined in the male cohort, neither the effects of Injury Severity [r = .09, p = .28, $\Delta R^2 = .017$, p = .38] nor Psychopathy [r = -.13, p = .19, $\Delta R^2 = .025$, p = .27] were significant although the overall pattern was maintained. *Note.* Interestingly, both Injury Severity [r = .35, p = .006, $R^2 = .176$, $\Delta R^2 = .10$, p = .017] and Psychopathy [r = -.28, p = .023, $\Delta R^2 = .056$, p = .072] emerged as predictors of intensity change scores for the negative-contrasting trials within the female cohort.

[50] Results from the regression analysis confirmed this finding; psychopathy emerged as a significant predictor of change in pleasantness ratings for the Neutral-Negative trials (p = .054) accounting for 4% of the unique variance in the criterion. Based on the direction of the relationship (r = -.21, p = .019), higher psychopathy was associated with lower change in pleasantness ratings despite receiving a negative context for previously rated neutral images.

significantly lower change in pleasantness ratings for the contrasting trials of Neutral images (i.e. Neutral-Negative), $F(1, 97) = 4.53$, $p = .036$, $\eta_p^2 = .045$; such that providing a negative context for a previously rated neutral image evoked relatively lesser change in ratings of pleasantness in individuals with higher psychopathy scores (see Figure 21).

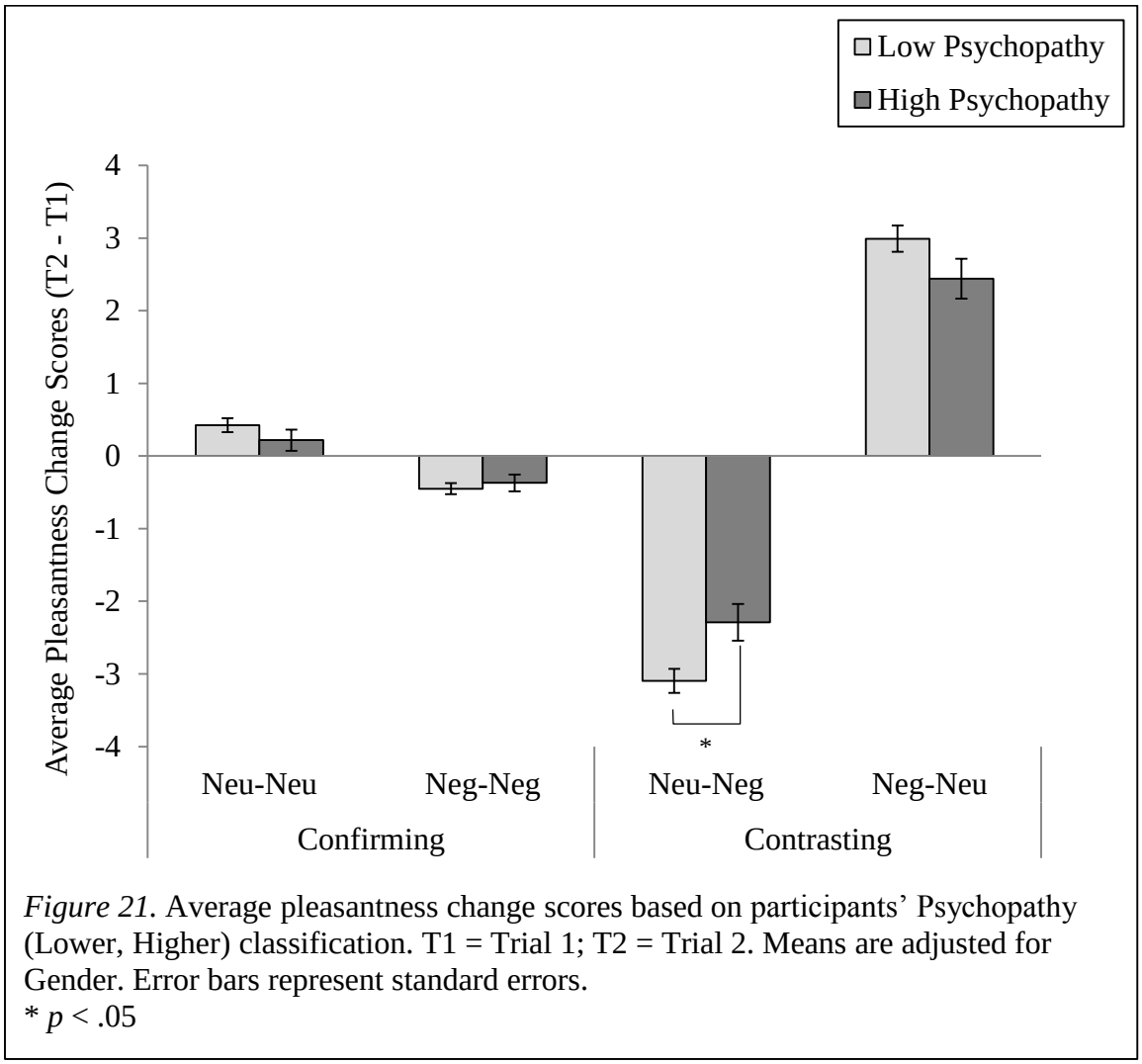

Figure 21. Average pleasantness change scores based on participants' Psychopathy (Lower, Higher) classification. T1 = Trial 1; T2 = Trial 2. Means are adjusted for Gender. Error bars represent standard errors.
* $p < .05$

Interestingly, a significant four-way interaction between Image Type x Context x Head Injury x Psychopathy, $F(1, 95) = 6.56$, $p = .012$, $\eta_p^2 = .065$[51], revealed the effect of Psychopathy

[51] This finding was confirmed in the male cohort where the 4 way interaction between Image Type x Context X Head Injury X Psychopathy was significant, $F(1, 43) = 6.41$, $p = .015$, $\eta_p^2 =$

for the neutral contrasting trials (i.e., Neutral-Negative condition) was restricted to the MHI group such that higher psychopathy was associated with lower change in pleasantness ratings only if they indicated a head injury, $F(1, 33) = 7.10$, $p = .012$, $\eta_p^2 = .18$[52]. Although less pronounced, higher psychopathy was also associated with lower change in ratings for the negative contrasting condition (i.e., Negative-Neutral) within the MHI cohort, $F(1, 33) = 4.11$, $p = .051$, $\eta_p^2 = .11$[53] (Figure 22).

.13. Follow up analyses found that individuals who scored higher on psychopathy displayed significantly lower change in pleasantness ratings for the contrasting trials of Neutral images (i.e. Neutral-Negative) only in the MHI group (M_{LP} = -3.35 SE = .36; M_{HP} = -2.21, SE = .32) [$F(1, 23) = 5.49$, $p = .028$, $\eta_p^2 = .19$]; versus the No MHI group [$F(1, 22) = .09$, $p = .772$, $\eta_p^2 = .00$

[52] Results from the confirmatory regression analysis found that Psychopathy accounted for greater variance in scores in the MHI group [r = -.32, $p = .029$; $\Delta R^2 = .05$, $F(1,33) = 1.91$, $p = .177$] relative to the No MHI group [r = -.18, $p = .081$; $\Delta R^2 = .03$, $F(1,61) = 1.66$, $p = .202$] for Neutral-Negative trials. Interestingly, results from exploratory analyses found the Callous Affect subscale of Psychopathy to be the best predictor of lower change scores within the MHI group [r = -.55, $p < .001$; $sr^2 = .15$, $t = -2.92$, $p = .007$]; versus the No MHI group where the Antisocial Behaviour subscale emerged as the best predictor [r = -.24, $p = .029$; $sr^2 = .05$, $t = -1.72$, $p = .092$].

[53] Results from the confirmatory regression analysis found Psychopathy to be associated with lower change in pleasantness for Negative-Neutral trials only in the MHI group [r = -.35, $p = .019$; $\Delta R^2 = .10$, $F(1,33) = 3.79$, $p = .060$]. In contrast, although not significant; psychopathy was associated with greater change scores in the No MHI group [r = .13, $p = .158$; $\Delta R^2 = .01$, $F(1,61) = .64$, $p = .428$], with the Interpersonal manipulation subscale of psychopathy being significantly predictive of greater change scores within this cohort [r = .28, $p = .013$; $sr^2 = .12$, $t = 2.87$, $p = .006$].

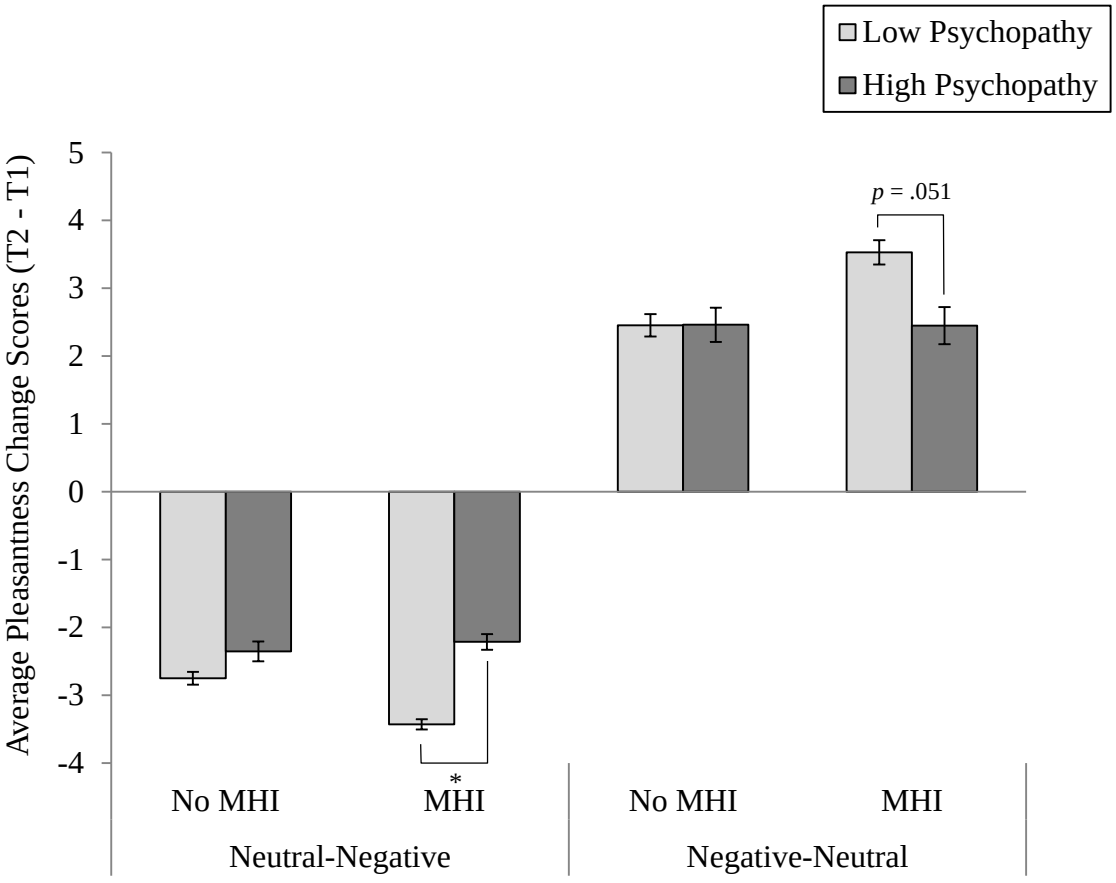

Figure 22. Average change in pleasantness ratings as a function of Psychopathy (Lower, Higher) for the contrasting condtions of Trial 2 of the EPT based on participants' Head Injury Status (No MHI, MHI). T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; Means are adjusted for Gender. Error bars represent standard errors.
* $p < .05$

Post-hoc analyses found the MHI-LP group to display significantly greater change in pleasantness ratings (in the expected direction) for the Neutral-Negative, $F(3, 95) = 3.38$, $p = .022$, $\eta_p^2 = .10$, and the Negative-Neutral trials, $F(3, 95) = 3.30$, $p = .024$, $\eta_p^2 = .09$, reflecting greater sensitivity to the context effect than the other groups[54]. The average change scores across conditions by group membership are illustrated in Figure 23.

[54] The same overall mean pattern was maintained in the male cohort. The MHI LP group displayed greater change scores for the contrasting conditions i.e., the Neutral-Negative [$M_{No\ MHI\ LP} = -2.47$, $SE = .36$; $M_{No\ MHI\ HP} = -2.64$, $SE = .43$; $M_{MHI\ LP} = -3.35$, $SE = .39$; $M_{MHI\ HP} = -2.21$, SE

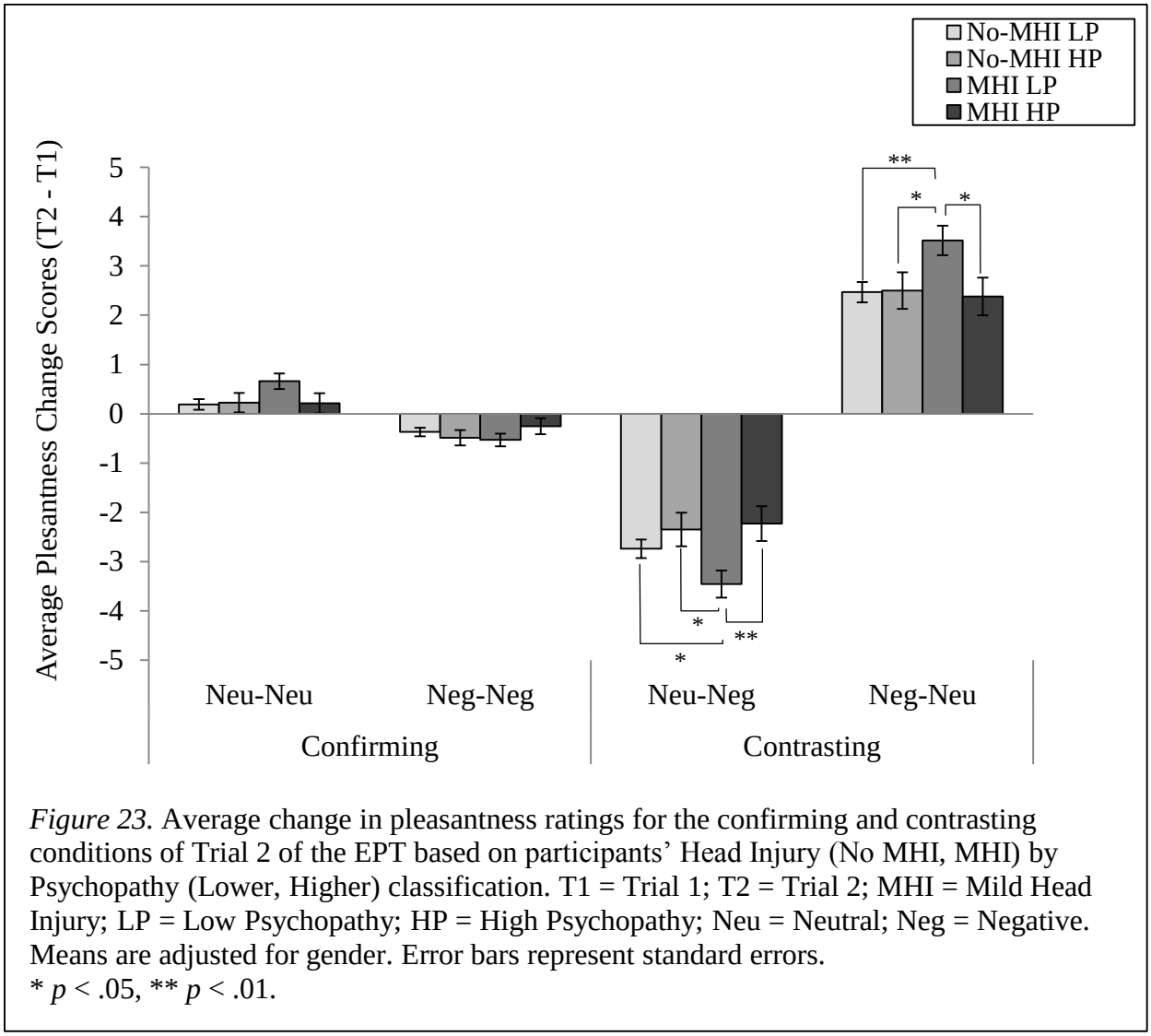

Figure 23. Average change in pleasantness ratings for the confirming and contrasting conditions of Trial 2 of the EPT based on participants' Head Injury (No MHI, MHI) by Psychopathy (Lower, Higher) classification. T1 = Trial 1; T2 = Trial 2; MHI = Mild Head Injury; LP = Low Psychopathy; HP = High Psychopathy; Neu = Neutral; Neg = Negative. Means are adjusted for gender. Error bars represent standard errors.
* $p < .05$, ** $p < .01$.

Pleasantness Change Scores and Injury Severity. The summary of results across the different conditions of Trial 2 is presented in Table 15. Injury severity did not emerge as a

= .35] and Negative-Neutral trials [$M_{No\ MHI\ LP}$ = 2.19, SE = .40; $M_{No\ MHI\ HP}$ = 3.20, SE = .48; $M_{MHI\ LP}$ = 3.43, SE = .43; $M_{MHI\ HP}$ = 2.54, SE = .39]; consistent with the results of the primary analysis.

significant predictor of change in pleasantness ratings for any of the conditions and hence has not been described[55].

Physiological Arousal

In addition to differential behavioural performance on the EPT, participants were expected to differ in their physiological response to emotive stimuli (i.e., neutral- and negatively-valenced images) as a function of their Head Injury and Psychopathy status. While MHI was expected to display physiological underarousal for both Neutral and Negative images (indicative of generalized underarousal), psychopathy was expected to display underarousal only for Negative images. Potential differences in physiological responsivity were thought to lend insights on the nature of emotion processing in head injury and psychopathy. Participants' physiological data was examined at rest (i.e., prior to any experimental manipulations) and while they viewed images on Trial 1 of the EPT[56].

Baseline Physiological Arousal. A 2 (Head Injury: No MHI, MHI) x 2 (Psychopathy: Lower, Higher) ANCOVA was conducted to examine group differences in physiological arousal (pulse frequency) at rest; Gender was used as a covariate. Only the effect of Gender was significant, $F(1, 90) = 3.97$, $p = .049$, $\eta_p^2 = .042$, with males displaying lower pulse frequency at baseline

[55] Although not supported in the male cohort, Injury Severity was associated with greater change scores for Neutral-Negative [r = .15, $p = .138$; $\Delta R^2 = .02$, $F(1, 50) = .89$, $p = .350$] and Negative-Neutral [r = .20, $p = .072$; $\Delta R^2 = .04$, $F(1,50) = 2.04$, $p = .159$] trials in the female cohort. Psychopathy on the other hand was associated with lower change scores accounting for 4% [r = -.20, $p = .074$; $\Delta R^2 = .04$, $F(1,51) = 2.15$, $p = .148$] and 0% [r = -.06, $p = .323$; $\Delta R^2 = .004$, $F(1,51) = .21$, $p = .647$] variance for the Neutral-Negative and Negative-Neutral conditions respectively.

[56] Note that while both EDA and pulse frequency data were analyzed, due to significant skewness in EDA data and absence of significant findings, only results obtained from participants' pulse frequency has been described. Physiological data was available from 94 participants.

(M_M = 72.81, *SE* = 1.46; M_F = 78.08, *SE* = 1.33)[57]. No group differences as a function of Psychopathy, $F(1, 90) = 2.21$, $p = .14$, $\eta_p^2 = .024$[58]; Head injury, $F(1, 90) = .89$, $p = .35$, $\eta_p^2 = .01$, or their Interaction, $F(1, 90) = 1.39$, $p = .24$, $\eta_p^2 = .015$, was significant[59].

Physiological Arousal while Viewing Images. A 2 (Image Type: Neutral, Negative) x 2 (Head Injury: No MHI, MHI) x 2 (Psychopathy: Lower, Higher) ANCOVA was conducted to examine group differences in physiological arousal (average pulse frequency) while participants viewed images on Trial 1 of the EPT; Gender was used as a covariate. Only a marginally significant effect of Gender was observed; $F(1, 90) = 2.95$, $p = .089$, $\eta_p^2 = .032$, with males displaying lower pulse frequency while viewing images (M_M = 74.31, *SE* = 1.27; M_F = 78.58, *SE* = 1.15)[60]. No group differences as a function of Psychopathy, $F(1, 90) = .63$, $p = .43$, $\eta_p^2 = .007$; Head injury, $F(1, 90) = .05$, $p = .82$, $\eta_p^2 = .001$, or their Interaction, $F(1, 90) = .20$, $p = .66$, $\eta_p^2 = .002$, were significant[61].

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[57] The effect of Gender was not significant within the No MHI LP (i.e., baseline) group (M_F = 78.42, *SE* =1.45; M_M = 75.41, *SE* = 2.51), $F(1, 46) = 1.08$, $p = .31$, $\eta_p^2 = .02$.

[58] Although not significant, results from the confirmatory regression analysis found Psychopathy [$r = -.26$, $p = .005$; $\beta = -.17$, $\Delta R^2 = .023$, $F(1, 92) = 2.35$, $p = .129$] to account for 2.3% additional variance over and above Gender [$r = -.27$, $p = .004$; $\beta = -.27$, $\Delta R^2 = .071$, $F(1, 93) = 7.15$, $p = .009$]. Interestingly, when examined separately as a function of MHI status, higher psychopathy scores [$r = -.34$, $p = .004$; $\beta = -.31$, $\Delta R^2 = .081$, $F(1, 57) = 5.25$, $p = .026$] were found to be predictive of lower pulse frequency at baseline only in the No MHI group, and explained 8.1% additional variance over Gender [$r = -.19$, $p = .07$; $\beta = -.19$, $\Delta R^2 = .038$, $F(1, 58) = 2.27$, $p = .14$] which accounted for only 4% of the variance. In contrast, Gender [$r = -.37$, $p = .014$; $\beta = -.37$, $\Delta R^2 = .139$, $F(1, 33) = 5.35$, $p = .027$] emerged as a better predictor of pulse frequency in the MHI group, accounting for 12% unique variance versus psychopathy scores which accounted for no variance [$r = -.15$, $p = .198$; $\beta = .06$, $\Delta R^2 = .003$, $F(1, 32) = .11$, $p = .748$].

[59] No significant effects were observed within the male cohort. The results are displayed in Table 16.

[60] The effect of Gender was not significant within the No MHI LP (i.e., baseline) group (M_F = 78.62, *SE* =1.35; M_M = 77.26, *SE* = 2.33), $F(1, 46) = .25$, $p = .62$, $\eta_p^2 = .01$.

[61] No significant effects were observed within the male cohort. The results are displayed in Table 17.

Interestingly, effects of Head Injury and Psychopathy emerged upon examining change in pulse frequency from baseline while viewing images on Trial 1. Change scores were calculated by subtracting participants' pulse frequency at baseline from their pulse frequency while viewing Neutral and Negative images respectively. A 2 x 2 x 2 ANCOVA was conducted with the same set of variables as previously indicated but with the change scores as the dependent measures. Results from the ANCOVA indicated no effect of Gender, $F(1, 89) = .44$, $p = .509$, $\eta_p^2 = .005$. Only the main effect of Head Injury was significant, $F(1, 89) = 5.23$, $p = .025$, $\eta_p^2 = .056$, with MHI individuals displaying significantly lower change in physiological responsivity (pulse frequency) from baseline while viewing images regardless of its valence (Figure 24).

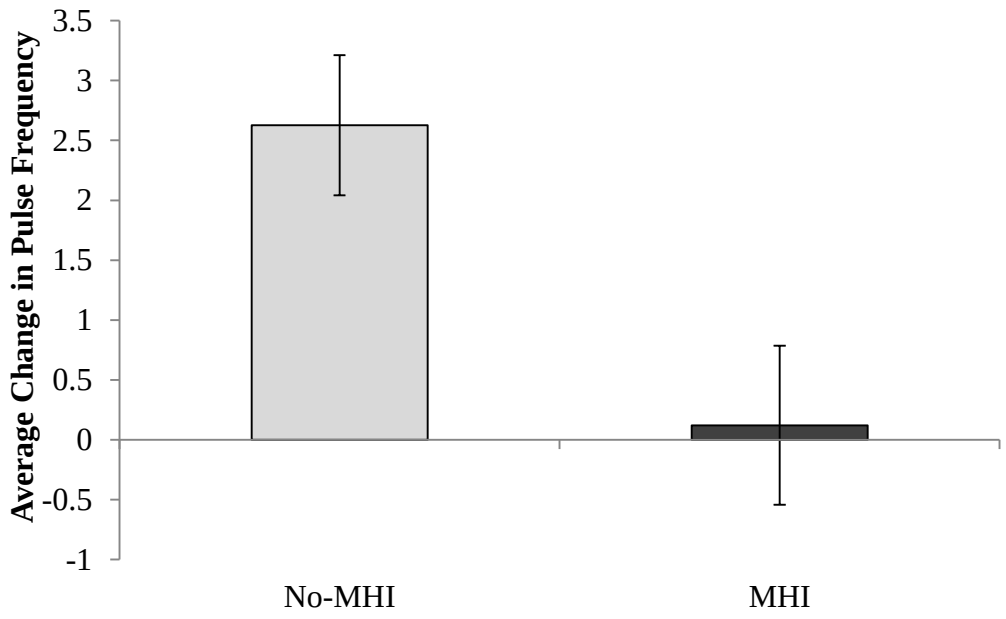

Figure 24. Participants' average change in pulse frequency from baseline while viewing images on Trial 1 as a function of their Head Injury (No MHI, MHI) status. MHI = Mild Head Injury. Means are adjusted for gender. Error bars represent standard errors.

In contrast, a marginally significant effect of Psychopathy, $F(1, 89) = 3.55$, $p = .063$, $\eta_p^2 = .038$, was found indicating that higher psychopathy scores were associated with a greater

change in physiological responsivity while viewing images as compared to baseline (M_{LP} = .37, *SE* = .48; M_{HP} = 2.07, *SE* = .76), particularly for the No MHI group as indicated by the Head-Injury x Psychopathy interaction, $F(1, 89) = 3.52$, $p = .064$, $\eta_p^2 = .038$. As illustrated in Figure 25, participants in the MHI group (regardless of their Psychopathy status) display no/minimal change in physiological responsivity while viewing both Neutral and Negative images as compared to baseline. The No MHI group, on the other hand, displays an increase in physiological responsivity, particularly in those with higher psychopathy. Interestingly, based on the pattern of means, while the No MHI LP group does not appear to differ with respect to physiological responsivity across Image Type, the No MHI HP group displays greater physiological responsivity for Neutral images relative to Negative, suggesting differential (attenuated) physiological response to negatively-valenced images[62,63].

[62] In fact when examined as a continuous variable (within the no-MHI group), psychopathy scores were found to be a significant predictor of increase in pulse frequency only while viewing Neutral images [r = .28, $p = .017$; $\beta = .29$, $\Delta R^2 = .068$, $F(1, 56) = 4.15$, $p = .046$] relative to Negative images [r = .22, $p = .046$; $\beta = .25$, $\Delta R^2 = .047$, $F(1, 56) = 2.75$, $p = .103$].

[63] No significant effects were observed within the male cohort. The results are displayed in Table 18.

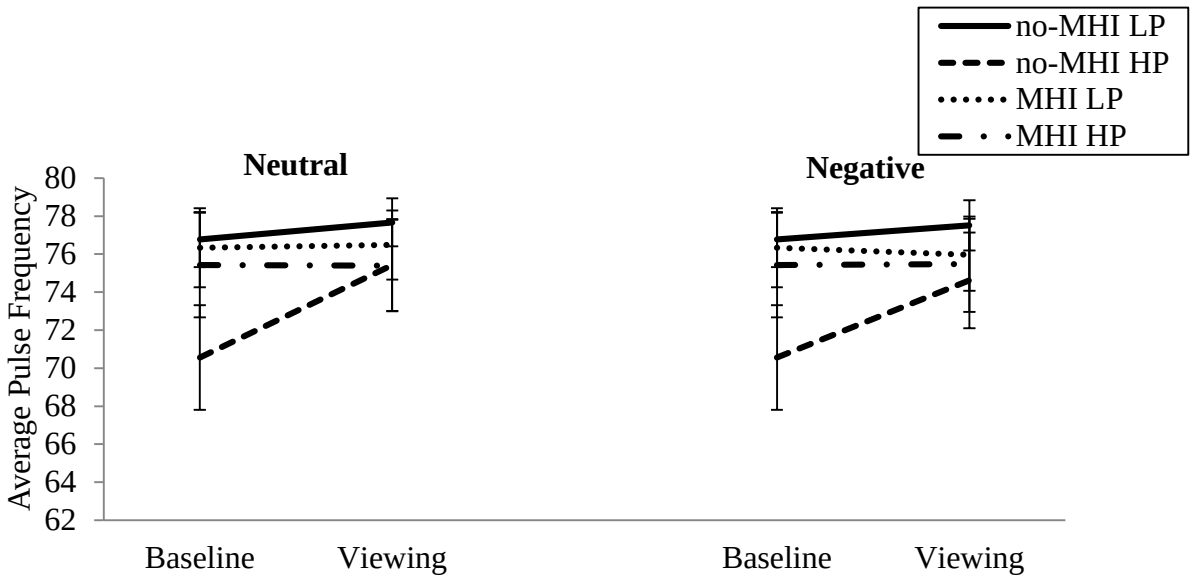

Figure 25. Average change in pulse frequency from baseline while viewing images (Neutral, Negative) on Trial 1 of the EPT as a function of participants' Head Injury (No MHI, MHI) by Psychopathy (Lower, Higher) classification. MHI = Mild Head Injury; LP = Low Psychopathy; HP = High Psychopathy. Means are adjusted for gender. Error bars represent standard errors.

Injury Severity and Physiological Arousal.

The regression coefficients of the hierarchical regression analyses predicting change in pulse frequency from baseline while viewing Neutral and Negative images from the Injury Severity Index has been displayed in Table 19. Injury Severity was found to be predictive of reduced pulse reactivity accounting for 7% and 4% of the variability while viewing Neutral [$F(1, 90) = 6.92$, $p = .01$][64]and Negative [$F(1, 90) = 3.79$, $p = .055$][65] images on Trial 1, displayed in Figures 26 and 27 respectively. Reduced physiological reactivity to images, irrespective of its

[64] Exclusion of influential cases (Participants 208 & 212) did not change the overall pattern of results with Injury Severity accounting for 6% of the variance in scores, such that greater injury severity was indicative of lower pulse change from baseline to viewing Neutral images [$r = -.18$, $p = .04$; $\beta = -.26$, $\Delta R^2 = .061$, $F(1, 88) = 5.89$, $p = .017$].

[65] Exclusion of influential cases (Participants 164, 208 & 212) did not change the overall pattern of results with Injury Severity accounting for 4% of the variability in scores such that greater injury severity was indicative of lower pulse change from baseline to viewing Negative images [$r = -.17$, $p = .06$; $\beta = -.21$, $\Delta R^2 = .04$, $F(1, 87) = 3.81$, $p = .054$].

valence, indicates generalized physiological underarousal in individuals with a MHI particularly with increase in severity of injury[66].

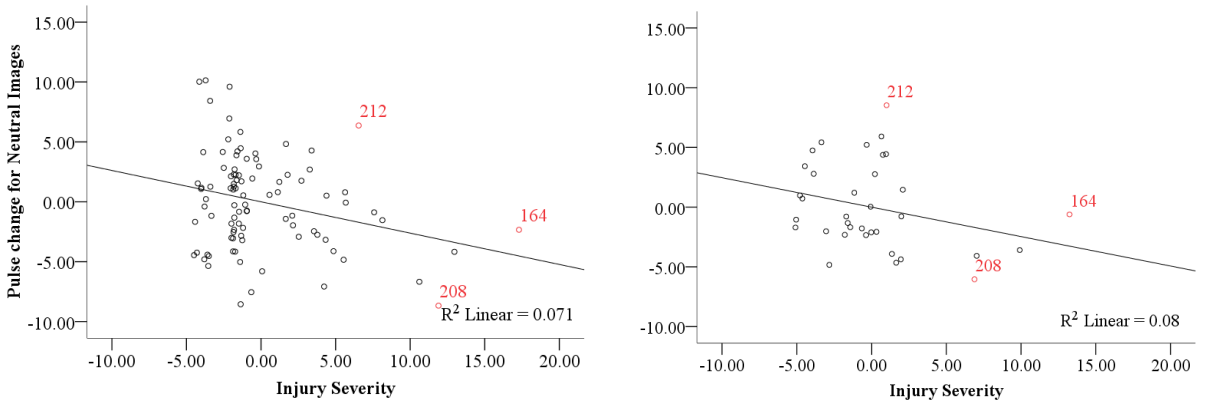

Figure 26. Scatterplots of residuals against predicted values depicting participants' physiological reactivity (pulse rate) while viewing Neutral images on Trial 1 as a function of Injury Severity (Severity Index). **A**. Includes all subjects (N = 94). **B.** Includes MHI subjects only (*n* = 35). Influential cases are highlighted.

[66] Although not significant, the same pattern was observed in the male cohort with injury severity accounting for 5% & 6% of the variance respectively, while viewing Neutral [r = -.24, *p* = .06; β = -.23, ΔR^2 = .053, *F*(1, 39) = 2.22, *p* = .14] and Negative Images On Trial 1 [r = -.24, *p* = .07; β = -.24, ΔR^2 = .058, *F*(1, 39) = 2.39, *p* = .13].

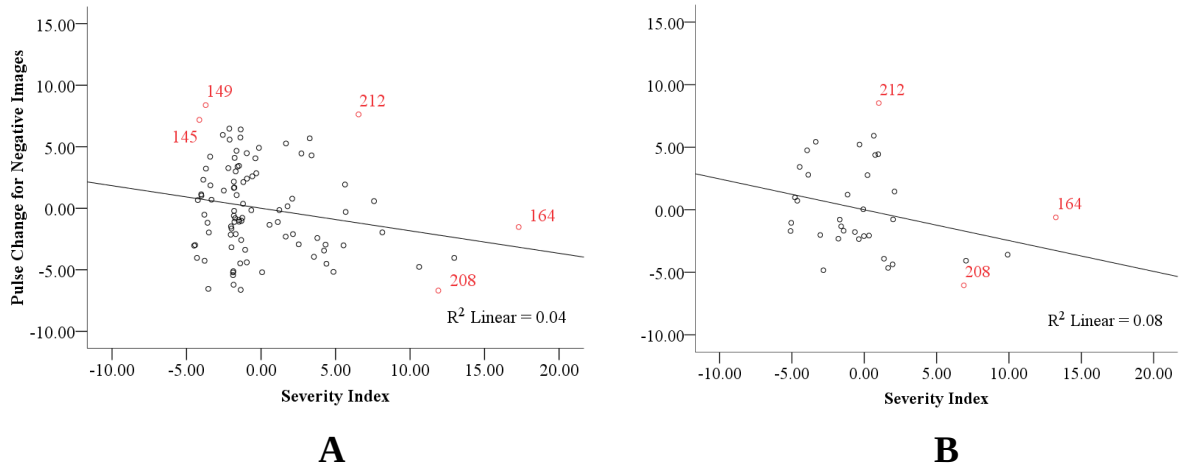

Figure 27. Scatterplots of residuals against predicted values depicting participants' physiological reactivity (pulse rate) while viewing Negative images on Trial 1 as a function of Injury Severity (Severity Index). **A**. Includes all subjects (N = 94). **B.** Includes MHI subjects only (*n* = 35). Influential cases are highlighted.

QCAE

As a secondary indicator of potential differences on the two components of Empathy (Affective, Cognitive), participants' scores on the Questionnaire of Cognitive and Affective Empathy (QCAE) were evaluated as a function of their Head Injury and Psychopathy status. A mixed model 2 (Empathy Factor: Affective, Cognitive) x 2 (Head Injury: No MHI, MHI) x 2 (Psychopathy: Lower, Higher) ANCOVA was conducted with Gender as a covariate.

Results from the ANCOVA found only the effects of Gender to be significant, $F(1, 95) = 2.98$, $p = .087$, $\eta_p^2 = .03$. Males displayed overall lower empathy scores ($M_M = 2.98$, $SE = .04$; $M_F = 3.15$, $SE = .04$), particularly on the affective empathy factor of the QCAE ($M_M = 2.80$, $SE = .05$; $M_F = 3.17$, $SE = .05$), $F(1, 95) = 18.21$, $p < .001$, $\eta_p^2 = .16$. No significant effects of

Psychopathy, $F(1, 95) = 1.68$, $p > .05$, $\eta_p^2 = .02$, Head Injury, $F(1, 95) = 1.91$, $p > .05$, $\eta_p^2 = .02$; or their Interaction, $F(1, 95) = 2.36$, $p > .05$, $\eta_p^2 = .024$, emerged[67].

QCAE and Injury Severity. Injury Severity significantly correlated with Affective Empathy (r = - .26, $p = .005$), such that greater severity of injury was associated with lower affective empathy. This was particularly pronounced in the male cohort; Injury Severity [r = -.31, $p = .016$; $\beta = -.27$, $\Delta R^2 = .07$, $F(1, 44) = 3.53$, $p = .067$] emerged as a marginally significant predictor of Affective Empathy accounting for 7.1% unique variance over and above Psychopathy [r = -.20, $p = .09$; $\beta = -.20$, $\Delta R^2 = .04$, $F(1, 45) = 1.91$, $p = .17$].

Interestingly, effects of Psychopathy and Injury Severity emerged for separate components of Affective Empathy. For instance, Psychopathy was found to be predictive of significantly lower Proximal Responsivity scores uniquely accounting for 10% of the variance over and above the effects of the other predictors[68]. Although significantly correlated (r = -.19, *p*

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[67] Results from the confirmatory regression analyses found higher psychopathy scores to be predictive of lower Affective (r = -.365, $p < .001$; $\Delta R^2 = .025$, $p = .077$) and Cognitive (r = -.13, $p > .05$, $\Delta R^2 = .034$, $p = .065$) empathy over and above the effects of Gender, which emerged as a significant predictor ($p = .001$) only for the Affective Empathy factor of the QCAE.
When examined separately as a function of MHI status, the effect of Psychopathy was maintained only within the MHI group where it accounted for 9% and 13% of additional variance (over and above Gender) in Affective and Cognitive[a] empathy, respectively, versus 0% and 3% within the No MHI group [$\text{Affective}_{No\ MHI}$: r = -.19, $p = .07$; $\beta = -.04$, $\Delta R^2 = .00$, $F(1, 61) = .10$, $p = .75$; Affective_{MHI}: r = -.51, $p = .001$; $\beta = -.34$, $\Delta R^2 = .083$, $F(1, 33) = 4.10$, $p = .05$; $\text{Cognitive}_{No\ MHI}$: r = -.13, $p = .33$; $\beta = -.18$, $\Delta R^2 = .027$, $F(1, 60) = 1.66$, $p = .20$; Cognitive_{MHI}: r = -.22, $p = .10$; $\beta = -.44$, $\Delta R^2 = .13$, $F(1, 32) = 4.99$, $p = .03$].
[a]*Note*. The results described exclude participants 198 (No MHI) & 131 (MHI) who were found to be significant outliers on the Cognitive Empathy factor of the QCAE.
[68] When examined separately based on Head Injury status, Psychopathy accounted for greater variance in Proximal Responsivity within the MHI group [r = -.52, $p < .001$; $\Delta R^2 = .12$, $F(1, 33) = 5.83$, $p = .022$] versus the No MHI group [r = -.32, $p = .005$; $\Delta R^2 = .08$, $F(1, 61) = 5.27$, $p = .025$]. Exploratory analyses indicated Callous Affect to emerge as the best predictor of reduced empathy in the MHI group [r = -.65, $p < .001$; $sr^2 = .150$, $t = -2.80$, $p = .009$] relative to the No MHI group; in the No MHI group Interpersonal Manipulation emerged as the best predictor [r = -.41, $p < .001$; $sr^2 = .115$, $t = -2.83$, $p = .006$].

= .027), Injury Severity was not predictive of scores on Proximal Responsivity after accounting for the effects of Psychopathy.

In contrast, the effect of Injury Severity was relatively more pronounced for the Emotion Contagion subscale. Greater severity of injury was associated with lower scores on Emotion Contagion (r = -.23, p = .012), uniquely accounting for 2% of the variance in scores in comparison to Psychopathy which explained no variance[69]. Gender emerged as the only significant predictor accounting for 6% of variance in scores[70]. The regression coefficients of the hierarchical regression analyses for the Affective Empathy factor of the QCAE and its constituent subscales are displayed in Table 20.

The effect of Injury Severity was also observed for the Cognitive Empathy factor of the QCAE. Unlike Affective Empathy, the effect of Gender was not significant. Both Psychopathy and Injury Severity were predictive of lower Cognitive Empathy uniquely accounting for 3.4% and 4.1% of the variance respectively. Interestingly, while Psychopathy was predictive of lower scores only within the Online Simulation subscale of Cognitive Empathy accounting for 12% of the variance; Injury Severity was predictive of lower scores on both subscales of Cognitive

[69] Interestingly, psychopathy scores correlated with lower scores on emotion contagion only within the MHI group (r = -.23, p = .094). Moreover, exploratory analyses found the Callous Affect subscale of Psychopathy to be the best predictor of lower emotion contagion within the MHI group [r = -.43, p = .004; sr^2 = .10, t = -2.02, p = .053], versus the No MHI group, for which Antisocial Behaviour emerged as the best predictor [r = -.28, p = .022; sr^2 = .08, t = -2.35, p = .022].

[70] When examined in the male cohort the same pattern was maintained. Injury Severity [r = -.24, p = .05; β = -.25, ΔR^2 = .06, F(1, 44) = 2.78, p = .10] accounted for 6% unique variance over and above Psychopathy [r = -.03, p = .43; β = -.03, ΔR^2 = .00, F(1, 45) = .03, p = .86], with greater severity of injury associated with lower Emotion Contagion scores.

Empathy, namely, Online Simulation[71] and Perspective Taking[72,73] accounting for 3.3% and 4.5% of the variability respectively. The reader is referred to Table 21 where a summary of results has been presented.

Global Executive Function

In order to verify participants' cognitive status, performance across three cognitive tasks targeting verbal fluency (Similarities), abstract problem solving (Matrix Reasoning - MR) and cognitive flexibility (Trail Making Task - TMT) were examined. These tasks were intended to be a measure of "global" executive function. Separate univariate ANCOVAs were conducted in order to examine performance across the three tasks as a function of Head Injury (No MHI, MHI) and Psychopathy (lower, higher) status, with Gender used as a covariate.

Participants' average performance across the three tasks based on their Head Injury and Psychopathy status are displayed in Table 22. No significant effects of Gender were observed. Marginally significant effects of Psychopathy (M_{LP} = 19.60, SE = .40; M_{HP} = 18.18, SE = .60), $F(1, 95) = 3.75$, $p = .06$, $\eta_p^2 = .04$; and Head injury ($M_{No\ MHI}$ = 18.26, SE = .46; M_{MHI} = 19.52, SE

[71] Participant 164 (extremity on the Severity Index) was found to be a significant outlier and was excluded from the analysis.

[72] Participants 198 (No-MHI) and 125 (MHI) were identified as significant outliers on Perspective Taking and were excluded from the analysis.

[73] Interestingly, additional analyses revealed Psychopathy to be associated with higher scores on Perspective Taking in males within the No MHI group, [r = .27, p = .11; β = .27, ΔR^2 = .07, $F(1, 20) = 1.57$, p = .22]. In contrast, higher psychopathy scores were associated with lower Perspective Taking in the MHI group [r = -.15, p = .24; β = -.15, ΔR^2 = .02, $F(1, 23) = .52$, p = .48]. Although not significant, these differential patterns may indicate important etiological differences in the manifestation of empathic differences in psychopathy and brain injury, as seen in clinical populations.

= .54), $F(1, 95) = 3.11$, $p = .081$, $\eta_p^2 = .03$ were observed for the MR task[74]. No significant group differences emerged on tasks assessing verbal fluency or cognitive flexibility suggesting comparable performance across participants irrespective of their group membership. Note that while effects of Injury Severity were examined across tasks of executive function, no significant effects were observed and hence have not been described.

Table 22

Participants' Average Performance Across Tasks Assessing Executive Function Based on their Head Injury and Psychopathy Status.

Group Membership		Similarities		MR		TMT	
		Descriptives					
	n	*M*	*SE*	*M*	*SE*	*M*	*SE*
No MHI LP	50	20.99	.58	19.33	.45	.73	.20
No MHI HP	14	19.01	1.04	17.20	.82	1.15	.37
MHI LP	21	21.34	.85	19.88	.66	.66	.29
MHI HP	15	21.40	1.08	19.16	.84	.65	.37
Total	100						

Note. *M* = Means adjusted for Gender, *SE* = Standard Error, MR = Matrix Reasoning Task, TMT = Trials Making Task assessing number of errors committed with lower scores indicative of better performance.

[74] *Note*. The assumption of homogeneity of error variances was violated ($p < .05$). Consequently, results were confirmed using the Mann Whitney-U test which did not yield significant differences on the MR task as a function of Psychopathy ($p = .16$) or Head Injury ($p = .43$) status. However, results from the confirmatory regression analysis found Psychopathy [$r = -.17$, $p = .047$; $\beta = -.26$, $\Delta R^2 = .05$, $F(1, 97) = 5.12$, $p = .03$] to be significantly predictive of performance on the matrix reasoning task with higher psychopathy associated with lower abstract problem solving, particularly within the No MHI group [$r = -.33$, $p = .004$; $\beta = -.33$, $\Delta R^2 = .14$, $F(1, 61) = 9.80$, $p = .003$]. The same overall pattern was maintained within the male cohort.

Discussion

The primary objective of the current study was to investigate potential differences in empathic response (affective and cognitive) and emotional processing in Mild Head Injury and sub-clinical Psychopathy, and their interaction. Participants, based on their Head Injury and Psychopathy status, were expected to mirror emotion processing deficits seen in clinical populations of brain injury and psychopathy, albeit to a subtler extent. Based on previous literature, it was hypothesized that MHI would be associated with reduced affective and cognitive empathy with injury severity (as a measure of injury characteristics and symptom manifestations) predictive of greater deficits in emotion perception; whereas, psychopathic tendency was expected to be associated with reduced affective empathy with capacity for cognitive empathy being relatively intact. Additionally, these groups were expected to differ physiologically, such that MHI individuals were expected to display generalized underarosual (irrespective of stimulus valence), while participants with greater levels of psychopathy were expected to display underarousal only for negatively-valenced stimuli. Lastly, Psychopathic tendency was expected to interact with MHI such that MHI individuals with higher psychopathy scores were expected to show the greatest compromise in empathic response.

Affective Empathy

Based on performance on Trial 1 of the EPT, results from the current study found MHI to be associated with reduced empathy ratings as a function of injury severity; individuals who endorsed more indices of MHI symptoms displayed lower empathy ratings for images, particularly of unpleasant scenes. Moreover, they reported feeling significantly less aroused while viewing negative images. A pattern of generalized underarousal was observed; injury severity was found to predict lower overall arousal ratings while viewing images. Similarly,

persons with MHI (irrespective of psychopathy) produced lower physiological reactivity (pulse rate) while viewing images on Trial 1, irrespective of its affective valence; with injury severity also being predictive of lower physiological reactivity.

These findings are consistent with the somatic marker hypothesis (Damasio et al., 1991). Processing emotional stimuli reactivates previously experienced somatic states associated with those stimuli (based on previous experiences; punishment/reward contingencies) and this peripheral physiological feedback regarding emotional activation influences our decision-making (Damasio et al., 1996). Other research has demonstrated that patients with vmPFC damage display deficient somatic states (Damasio et al., 1990; Damasio et al., 1996) when processing emotionally-charged stimuli, and this diminished response has been shown to play a critical role in these persons' risk-taking decisions (Bechara et al., 1994; Bechara et al., 2000). The findings in this study of reduced subjective experience of arousal, as well as dampened physiological reactivity, particularly for Negative images, may be indicative of deficient somatic markers in Mild Head Injury. This would be consistent with previous findings from our lab (Baker & Good, 2013) and could implicate disruption to the vmPFC, found to be particularly susceptible in close headed injuries (Bigler, 2008; Morales et al., 2005). Reduced arousal, particularly while viewing negative images, indicates lower emotion contagion in this cohort, with greater deficits witnessed as a function of increases in injury severity. Consistent with other reports of generalized hypoarousal and emotion processing deficits witnessed in more severe TBIs (e.g., Sanchez-Navarro, Martinez-Selva & Roman, 2005; deSousa et al., 2010; MacDonald et al., 2011), current findings provide evidence of reduced affective empathy in individuals reporting Mild Head Injury, consistent with our hypotheses.

Despite the evidence of reduced emotional arousal (as measured by subjective experience, and pulse rate), MHI individuals (particularly with lower psychopathy) displayed empathy ratings comparable to the No MHI group. Further, MHI subjects rated Negative images as equally intense and unpleasant as their No MHI cohort. This discordance between physiological *experience* and *perception* of emotion has been reported in studies examining emotion processing in TBI (e.g., MacDonald et al., 2011). VmPFC damage (susceptible in MHI) has been associated with blunted physiological/emotional responsivity and social misconduct in the absence of cognitive deficits and preserved knowledge of social rules and conventions (Saver & Damasio, 1991). Considering the nature of the current task which involved passive viewing of emotional scenes and no complex decision making, it is probable that the MHI group rated negative images based on their social knowledge base (i.e., what they should be feeling based on social beliefs, experiences, etc.) versus their physiological response (i.e., what they were actually feeling), and thus rated negative images as evoking higher empathy, more intense and unpleasant despite finding them less arousing. That said, when empathy ratings were examined as a function of injury severity, reporting a pre-existing head injury did predict lowered empathy.

Emotion processing deficits as a function of Psychopathy were found to be more pervasive. As hypothesized, individuals who scored higher on psychopathy provided lower empathy ratings, particularly for negative images. They were also more likely to rate negative images as relatively less intense and less unpleasant than their lower psychopathy cohort. These findings are consistent with the emotion perception literature that reports psychopathy is associated with abnormal processing of negatively-valenced stimuli and lend support to the "specific emotional deficit hypothesis" (see review by Blair, 2005; more recently by Brook et al., 2013).

Importantly, however, the results from the study found that all effects associated with psychopathy were confined to the MHI group, such that individuals with higher psychopathy were likely to rate negative images as evoking less empathy, less arousing, less intense, and less unpleasant, only if they indicated a history of head trauma (MHI).

Of particular interest was the finding that the Callous Affect component of Primary Psychopathy emerged as the best predictor of reduced empathic ratings within this cohort; analogous to the reduced emotional reactivity found in the MHI group. This is particularly interesting as MHI, as a main effect, was not associated with higher scores on callous affect and, instead, as a group, scored higher on Secondary Psychopathy. Indeed, callous affect accounted for a significant percentage of the variance in secondary psychopathy (28%) in the MHI group versus 3% in the No MHI group. Together, these findings may indicate that individuals in the MHI group are likely to engage in greater risk-taking behaviors due to reduced emotional activation and absent/deficient somatic markers (callous affect), feedback that is thought to sub-serve advantageous decision-making (Damasio et al., 1990; Damasio et al., 1991).

The absence of psychopathy influencing empathic performance in the No MHI group was unexpected, but was only observed in their ratings of negative images. On other empathy measures, empathy differences were found. For example, when subjects were to endorse descriptions of his/her empathic behaviour (i.e., on the QCAE) persons those who ranked higher on psychopathy endorsed experiencing lower proximal responsivity, a measure of affective empathy, even in persons with No MHI. That is, psychopathy was significantly associated (negatively) with one's capacity to emotionally respond to another's distress, a reflection of compassion (e.g., "I often get emotionally involved with my friends' problems"). In contrast, psychopathy was unrelated to the emotion contagion measure, the tendency to automatically

mirror another's emotions (e.g., "I am happy when I am with a cheerful group and sad when the others are glum"). These effects were maintained for both MHI and No MHI groups. In other words, lower capacity for empathy towards others is associated with psychopathic tendencies. As such, the task demands of the EPT (which involved the rating and passive viewing of neutral and negative scenes) may not be sufficiently sensitive to capture the perspective of the psychopathic cohort.

In contrast, MHI subjects (with higher psychopathic characteristics) were more likely to endorse both lower proximal responsivity and emotion contagion descriptions of his/her behaviour, in addition to providing lower empathy ratings to negative scenes, as compared to the No MHI group. Further, while callous affect emerged as the best predictor of lower proximal responsivity within the MHI group, interpersonal manipulation emerged as the best predictor of lower proximal responsivity in the No MHI group. These different patterns may indicate the involvement of different underlying processes (mechanisms) in the manifestation of empathic deficits associated with head injury and subclinical psychopathy.

Unlike with the MHI group (that displayed generalized physiological underarousal, irrespective of psychopathy status), higher psychopathy in the No MHI group was associated with overall lower, but greater change, in physiological reactivity in response to viewing the images consistent with earlier accounts which report increased cardiovascular reactivity in individuals with higher psychopathy, in both forensic (Hare, Frazelle & Cox, 1978) and community settings (Ishikawa, Raine, Lencz, Bihrle & Lacasse, 2001) Interestingly, they displayed greater change to Neutral relative to Negative images, possibly indicating differential processing of negatively-valenced stimuli, lending partial support to our hypothesis.

The differential pattern of results witnessed in the No MHI and MHI groups with higher psychopathy in the current study may mimic the theoretical profiles of "successful" and "unsuccessful" psychopaths in the community (Ishikawa et al., 2001). "Successful" psychopaths are described as individuals who score higher on the core factors of psychopathy but are "successful" in avoiding incarceration and do not show the frontal deficits witnessed in criminal ("unsuccessful") psychopaths (e.g., Widom, 1978). Ishikawa and colleagues (2001) found that despite both groups scoring higher on total psychopathy (i.e., PCL-R scores), "successful" psychopaths differed from "unsuccessful" psychopaths on other several characteristics. For example, in addition to displaying better neuropsychological competence, "successful" psychopaths were found to display increased physiological reactivity (heart rate) when anticipating an emotional stressor, while "unsuccessful" psychopaths displayed reduced physiological reactivity (not unlike the pattern observed in our study for No MHI HP versus MHI HP subjects). Moreover, "unsuccessful" psychopaths were found to score higher on Factor 2(i.e., the Secondary Psychopathy component of the PCL-R), but did not differ from "successful" psychopaths on Factor 1 (i.e., Primary Psychopathy). Consistent with these findings, the MHI group in the current study was found to differ from the No MHI group only on the secondary component of psychopathy, with greater injury severity associated with greater scores on Anti-Social Behavior. While Ishikawa et al. (2001) did not report a higher incidence of head injury (based on cell counts) in their sub-group of "unsuccessful" psychopaths, 51% of their total sample reported a history of head injury, warranting an investigation of its effects.

In related research, Yang and colleagues (e.g.,Yang, Raine, Colletti, Toga, & Narr, 2010) found significantly less gray matter volume/cortical thickness in the orbital frontal cortex (vmPFC) (susceptible in close headed injuries) of only "unsuccessful" psychopaths as compared

to "successful" psychopaths and controls. While both psychopathy groups displayed reduced volume of the amygdala relative to controls, they did not significantly differ from one another. Thus, "unsuccessful" psychopaths (from criminal populations) were unique in displaying OFC disruption. While these authors did not assess for the incidence of TBI in their study, the vmPFC is considered to be particularly susceptible to insult in closed head injuries including Mild TBI (Bigler, 2008; Morales et al., 2005). In fact, recent reports assessing prevalence of TBI in prison populations indicate that the majority are mild in nature (Willams et al., 2010). Our findings highlight the significance of considering head injury status in psychopathic populations, and have important treatment implications, particularly in forensic settings if, indeed, the nature of affective empathic responding, and lack thereof, are different.

Cognitive empathy

Cognitive context was associated with differential patterns of performance as a function of MHI and Psychopathy. MHI individuals (particularly those with lower psychopathy) displayed enhanced sensitivity to contextual cues and displayed ratings that were consistent with the intended manipulation (i.e., of changing the 'meaning' of the pictorial display – making neutral pictures more negative and negative pictures less so). Despite this, MHI was associated with reduced ratings of subjective arousal, particularly while viewing Negative images, providing further evidence of the discordance in physiological experience (participants' lower arousal ratings) and perception of emotion (participants' ratings of empathy, intensity and pleasantness as influenced by the cognitive context) in TBI (MacDonald et al., 2011; Saver & Damasio, 1991).

Neutral to Negative trials (i.e., neutral images accompanied by negative scenarios), intended to assess the influence of cognitive interpretations on empathy, evoked greater change

in ratings in the MHI group (particularly those with lower psychopathy) for all behavioural measures except arousal, where injury severity was found to be predictive of significantly lesser change in ratings. The effects of head injury were particularly noted for the Negative to Neutral trials (i.e., negative pictures accompanied by neutralizing scenarios). When presented with contextual information intended to neutralize the emotional impression of a previously rated Negative image, MHI individuals displayed greater change in their ratings and rated them as significantly less intense and more "neutral". This context dependence was enhanced as a function of injury severity with greater severity of injury being associated with greater change scores. Callous affect was found to be the best predictor of greater change in ratings implicating potential vmPFC disruption.

Based on the pattern of results, it would appear that the MHI group (in the absence of somatic markers, but having intact cognitive faculties) was less affected by the emotional content of the images and more readily adjusted their ratings to be in line with the cognitive context provided. In contrast, the Negative images remained emotionally provocative (i.e., did not change their empathy, intensity and pleasantness ratings to the same extent) and were rated as being more arousing for the No MHI group for whom the emotional component of the visual stimuli outweighed the neutrality of the contextual information provided. Arousing emotional stimuli have been shown to cause greater emotional interference and concurrently affect task performance in normal subjects (e.g., Verbruggen & Houwer, 2007). Similar findings are seen in studies assessing moral decision making in individuals with damage to the vmPFC. Relative to controls, vmPFC patients in the absence of somatic markers but intact cognitive comprehension, are able to contemplate moral dilemmas in a more "rational" and "calculated" fashion, and

commit personal moral transgressions in lieu of "utilitarian" considerations (Ciaramelli, Muccioli, Ladavas & Pellegrino, 2007, Koenigs et al., 2007).

Conversely, Psychopathy was associated with significantly lower change in ratings of empathy, arousal, intensity and pleasantness from Trial 1, despite receiving contextual information intended to evoke heightened empathy and emotional responsivity. This was particularly noted for Neutral to Negative trials (i.e., neutral pictures accompanied by negative scenarios) indicating that psychopathic tendencies are less impacted by emotional cues and display reduced cognitive empathy (consistent with findings from Brook & Kosson, 2013). However, the effect of Psychopathy was significant only for participants who indicated previous head trauma. Further, as with affective empathy (Trial 1), callous affect emerged as the best predictor of reduced change scores, particularly for arousal ratings. Together, these findings implicate both affective and cognitive empathic deficits observed in this cohort. Moreover, Injury severity was found to be predictive of lower online simulation, and perspective taking, suggesting pervasive deficits in cognitive empathy as a function of increased injury severity; consistent with previous studies that have found impaired perspective taking and cognitive empathy in severe TBI (Muller et al., 2010; deSousa et al., 2010).

While greater deficits in empathy (affective and cognitive) as a function of injury severity may be attributed to more extensive frontal damage (e.g., extending to the dlPFC), participants were not found to differ on tasks of executive function as a function of Head Injury or Injury severity. Moreover, MHI individuals displayed enhanced sensitivity to context which was found to correlate with increased injury severity. Based on models of empathy, sympathetic concern (proximal responsivity) and perspective taking are contingent on one's capacity for "affect sharing", i.e., emotion contagion (De Waal, 2008). Participants in the MHI group in the current

study were found to be compromised on emotion contagion, which may explain the nature of pervasive deficits observed. Future research assessing other factors implicated in emotion perception deficits in TBI such as impaired affect recognition (e.g., Babbage et al., 2011; Radice-Neumann, Zupan, Babbage, & Willer, 2007) and attentional abnormalities (e.g., McDonald et al., 2011) in this cohort will help further clarify the nature of empathy and emotion processing which, in turn, would have important implications in the treatment of social deficits prevalent in TBI.

Consistent with the concept of the "successful psychopath" (Widom, 1978), psychopathy in the No MHI group was not associated with reduced cognitive empathy, consistent with other reports assessing "successful" psychopaths in the university population (e.g., Mullins-Nelson, Salekin & Leistico, 2006). Interestingly, male participants with higher psychopathy scores (and without MHI) displayed greater change in ratings of intensity and pleasantness (in line with the contextual information) for neutral images provided with negative contextual interpretations, and displayed higher scores on perspective taking (QCAE), displaying trends of enhanced cognitive empathy within this cohort. Interestingly, the Interpersonal Manipulation subscale of psychopathy was found to be the best predictor of greater sensitivity to contextual cues and higher perspective taking. These findings are consistent with those reported by Book et al. (2007) who found evidence of enhanced sensitivity to cues of vulnerability in confederates (thought to aid in victim selection), in individuals higher on the interpersonal-affective factor of psychopathy in prison inmates and university students (Wheeler, Book & Costello, 2009). Evidence of *enhanced* cognitive empathy was only noted with male subjects. This is not surprising considering that gender differences have been noted as pronounced in the psychopathy construct,

with traditional measures being more sensitive to capturing psychopathic characteristics in males (Forouzan & Cooke, 2005; Dolan & Völlm, 2009; Kreis & Cooke, 2011).

While displaying intact perspective taking, greater psychopathic tendencies were associated with lower scores for the Online Simulation subscale (QCAE). While perspective taking involves considering another's viewpoint based on their knowledge, intentions, etc. (e.g., "I am quick to spot when someone in a group is feeling awkward or uncomfortable"; "I can easily work out what another person might want to talk about"); online simulation involves a deliberate attempt to consider another's emotional state/feelings by imagining oneself in their situation, and reflects future intentions (e.g., "Before criticizing somebody, I try to imagine how I would feel if I was in their place"; "I always try to consider the other fellow's feelings before I do something") (Reniers, 2011). Consistent with these results, Shamay Tsoory et al. (2010) found psychopathy to be associated with selective impairment in "affective" theory of mind which entails making inferences about another's emotional state (similar to online simulation); but intact "cognitive" theory of mind which entails making inferences about another's beliefs (similar to perspective taking). These findings implicate the importance of including "affective" theory of mind tasks in studies assessing cognitive empathy in psychopaths, involving active consideration of others' feelings/emotional state. Current findings lend support to the "callous empathy" concept postulated by Book et al. (2007) according to which the empathic deficits observed in psychopathy (specific to our No MHI group) are not due to disadvantaged perspective taking and understanding others' mental state (found to be intact), but rather stems from being unable to emotionally respond to them; as reflected in their lower scores on Proximal Responsivity and Online Simulation, and differential (reduced) physiological reactivity to negatively-valenced images relative to neutral images.

Summary of Findings and Implications

The primary objective of the current study was to investigate potential differences in empathic response (affective and cognitive) and emotional processing in Mild Head Injury and sub-clinical Psychopathy, and their interaction. As noted in *Hypothesis I*, MHI was expected to be associated with reduced affective and cognitive empathy with injury severity (as a measure of injury characteristics and symptom manifestations) predictive of greater deficits in emotion perception. Participants were further expected to differ physiologically with persons who have experienced MHI displaying generalized underarousal. Consistent with my hypotheses, the current study found evidence of reduced affective empathy (based on participants' empathy and arousal ratings on the EPT) and cognitive empathy (based on results from the QCAE) in a sample of university students indicating a history of Mild Head Injury (MHI) (as a function of injury severity). Additionally, MHI subjects (with lower psychopathy) were found to reflect enhanced sensitivity to the cognitive context and were less affected by the emotional content of the images (based on their T2 change scores). This context-dependence (irrespective of affective valence) was found to increase as a function of injury severity. As expected in *Hypothesis II*, the MHI group was found to be underaroused, based on both their subjective experience (overall empathy and arousal ratings on Trial 1 of the EPT) and their physiological reactivity to emotional images (irrespective of valence), both of which became even more pronounced (i.e., lessened) as a function of injury severity (*Hypothesis III*). Current findings are in line with the somatic maker hypothesis (Damasio et al., 1991) and findings associated with disruption to the vmPFC, noted to be susceptible in closed head injuries (Bigler, 2008). This implies that even mild trauma to the head (without LOC) may be sufficient to produce differential behavioural

responding that mirror challenges observed in clinical populations, following a continuum of injury severity.

The nature of deficits in empathy and emotion processing as a function of psychopathy differed based on participants' head injury status. Psychopathy was expected to be associated with reduced affective empathy, with their capacity for cognitive empathy being relatively intact. Moreover, unlike MHI, psychopathy was expected to display physiological underarousal only for negatively-valenced stimuli. These predictions were only supported in the No MHI group where higher psychopathy was associated with intact perspective taking but displayed constraints on affective empathy based on their pattern of results from the QCAE. While not displaying significantly lower arousal while viewing Negative images, they displayed greater change to Neutral relative to Negative images, possibly indicating differential processing of negatively-valenced stimuli, lending partial support to my hypothesis.

In contrast, consistent with my prediction of the head injury by psychopathy interaction (*Hypothesis IV*), MHI subjects who scored higher on psychopathy, displayed the greatest compromise in empathic responding and demonstrated significant constraints in both affective and cognitive components of empathy and emotion processing. Interestingly, the Callous Affect component of psychopathy was found to account for the empathic and emotion processing deficits observed only for individuals who report a MHI, further implicating potential vmPFC disruption.

The results from the current study have several important social implications. For example, students, particularly those at the risk of repeated trauma (e.g., those engaging in high contact sports) in conjunction with certain personality profiles (higher psychopathic

characteristics) (Barrash et al., 2000; Tranel et al., 2005) may be at particular risk of social isolation (deficient empathy may impair quality of relationships, increase social conflict) and poor decision-making (absence of visceral feedback may lead to higher risk-taking behaviours such as drug abuse, unprotected sex, drinking and driving) leading to unfavorable outcomes in the community and workplace (Bechara et al., 1994; Damasio et al., 1991). Our findings further highlight the importance of considering head injury in vulnerable populations displaying greater antisociality, and problems with social integration, as in forensic settings. Williams and colleagues (e.g., Williams, Cordan, Mewse, Tonks & Burgess, 2010) investigating the prevalence of TBI (with LOC) in male adolescent offenders reported a high incidence of TBI of varying severities, with majority of these cases being "mild". Moreover, greater frequency of injuries (more than three) was associated with a greater number of convictions and increased the risk of violent offence and recidivism. In the current sample, almost half (i.e., 47%) of the MHI group reported having sustained multiple injuries, with 20% indicating three or more injuries. Consistent with this, injury severity was related to greater antisocial and risk-taking behaviors and was found to be significantly predictive of greater alcohol and drug use.

Interestingly, the MHI group with higher psychopathy displayed reduced physiological reactivity and was associated with higher scores on the Secondary Factor of the SRP-III consistent with the profile of "unsuccessful" psychopaths (Ishikawa et al., 2001) who are known to show pervasive deficits in empathic response (also observed in our MHI HP group). Considering these commonalities, treatment interventions aimed at improving emotional processing in individuals with brain injury (e.g., Bornhofen & McDonald, 2008b; Neumann, Zupan, Tomita & Willer, 2009) may be applied to vulnerable populations displaying similar

deficits/profiles. For instance, considering the selective influence of callous affect in explaining the emotional deficits observed in our MHI cohort, intervention strategies aimed at increasing arousal levels may assist in ameliorating the pervasive nature of emotional deficits in forensic populations with similar profiles, e.g., "unsuccessful" psychopaths (Yang et al., 2010).

Finally, our results lend important insights on the nature of empathic deficits observed in head injury and subclinical psychopathy, which could extend to clinical presentations of brain injury and psychopathy, implicating the involvement of differential underlying mechanisms for similarly expressed empathic deficits. Future research is needed to investigate the nature of these factors such as affect recognition deficits and attentional abnormalities; which may help clarify subtle differences in the manifestation of empathic differences across both cohorts.

Limitations

The current study has several limitations that need consideration. First, due to the unequal distribution of females across groups as a function of MHI and Psychopathy categorization; the effects of Gender had to be co-varied, resulting in a loss of power. Moreover, Gender effects are noted for Empathy (Hoffman, 1977), Psychopathy (Forouzan & Cooke, 2005) and TBI (Laker, 2011), which may have affected the pattern of results obtained in this study. In consideration of these factors, all observed effects were confirmed (i.e., analyzed separately) in male participants and the overall pattern of results was maintained. Future research assessing for these relationships in separate samples of males and females will minimize these potential confounds, and provide clearer insight as to the nature of effects.

Second, the current study assessed for MHI (and related injury characteristics and symptom manifestations) based on self-report in the absence of medical records. Consequently, we had no means of verifying the true incidence of MHI in the current sample. Research by

McCrea and colleagues (e.g., see McCrea, Hammeke, Olsen, Leo & Guskiewicz, 2004) reported a high incidence of concussions that went unreported in high school football players. Their findings indicated that the most common reasons for injuries going unreported were due to players thinking that their injury was not serious enough to warrant medical attention, not wanting to be withheld from future playing, and lack of awareness of having sustained a probable concussion (McCrea et al., 2004). 96.1% of our MHI group indicated having played competitive high-contact sports in high school (e.g., football, hockey, soccer) of which only 27% sought medical treatment in relation to their injury, and 38% reported having sustained a "diagnosed" concussion. Considering these discrepancies and absence of medical records, it is probable that the MHI group in the current sample was under-represented, leading to an attenuation of the observed effects.

Moreover, the current study assumes frontal damage in the MHI cohort in the absence of neuroimaging evidence. Closed head injuries (represented in the current sample) tend to be diffuse in nature, introducing a large amount of heterogeneity in injury mechanics and site of injury (and may explain the high incidence of influential cases within the Severity Index). As a result, the vmPFC cannot be directly implicated in the absence of imaging evidence, despite our descriptions of its possible contribution (i.e., due to its proximity to boney protrusions of the cranium (Morales et al., 2005), it tends to be most susceptible to injury as a result of the angular/rotational forces generated during concussive type injuries (Bigler, 2008). However, the overall pattern of results as a function of MHI, particularly our findings relating to reduced emotional reactivity (following a continuum of injury severity) and callous affect, are consistent with reports from patients with focal lesions (Damasio et al., 1996; Saver & Damasio, 1990) and severe TBI (deSousa et al., 2010).

Third, the study employed still images depicting neutral and unpleasant scenes to investigate empathy and emotion processing. Use of still images may not be representative of realistic social interactions which require complex integration of visual and auditory cues, and raises concerns regarding the generalizability of findings (deSousa et al., 2011). The images used in the current study were selected due to being supported by normative data and having been shown to have good ecological validity, reflective of scenarios encountered in everyday life (Bradley & Lang, 2000); and have demonstrated reliable emotional reactivity in other studies (deSousa et al., 2011). Furthermore, preliminary manipulation checks in this study found participants responded to the pictures in the expected direction (Trial 1), and consistent with the intended manipulations (Trial 2). However, considering the differential effects of psychopathy in the No MHI and MHI groups observed in the current study, and the complex nature of empathy, use of videotapes (involving visual and auditory cues and multiple modalities) in assessing emotion processing, will both improve generalizability, and may capture differences in the nature of emotion processing and perception between groups (deSousa et al., 2011).

Lastly, the quasi-experimental nature of the current study restricts our ability to make causal links between MHI and the empathic and emotion processing deficits observed in the current study. Pre-injury personality characteristics may predispose certain individuals to engage in certain activities that increase their likelihood of sustaining a head injury. While personality characteristics are important to acknowledge, results from the current study found the important influence of a severity continnum, such that participants displayed greater emotional deficits and physiological underarousal as a function of an increase in injury severity (based on injury characteristics, frequency of injuries and symptoms manifestations). Moreover, the results from

the current study found callous affect to account for all the empathic and emotional processing deficits observed in MHI, consistent with their reduced physiological arousal while viewing images. This is particularly interesting as MHI was not associated with higher scores on callous affect, but scored higher on components of secondary psychopathy. However, further research is needed to elucidate the influence of certain pre-injury personality factors (e.g., psychopathy; and other factors that may display a predisposed empathic deficit) and their interaction with neural disruption (as in MHI) in assessing clinical manifestations of empathic and emotional challenges post head trauma.

Conclusions

In conclusion, findings from the current study suggest that even mild trauma to the head, resulting in an altered state of consciousness (with or without loss of consciousness) may be sufficient in producing differential responding (relative to controls) that mirror deficits seen in clinical populations, following a continuum of injury severity. University students indicating mild head injury displayed reduced affective empathy and constraints with cognitive empathy (as a function of injury severity), with more "severe" injuries associated with more pronounced deficits. Psychopathy interacted with head-injury such that MHI individuals with higher psychopathy were found to display the greatest compromise in both aspects of empathy, rendering these individuals to be at particular risk of social conflicts and poor interpersonal success. In addition to displaying reduced physiological reactivity, they reported engaging in greater risk-taking and antisocial behaviours consistent with the profile of "unsuccessful" psychopathy (Ishikawa et al., 2001). Interestingly, callous affect was found to be selectively predictive in explaining the empathic challenges seen in the MHI group, and may implicate (or,

at the least, mirror) disruption to the vmPFC. In contrast, Psychopathy (in the absence of head injury) was associated with increased physiological reactivity and demonstrated constraints with affective empathy while reflecting intact perspective taking, consistent with the profile of "successful" psychopathy (Ishikawa et al., 2001). These differential patterns suggest involvement of differential underlying mechanisms behind similar empathic deficits in MHI and psychopathy, and highlight the significance of assessing for head injury in psychopathy, particularly those scoring higher on secondary psychopathy.

The empathic and emotion processing difficulties observed in the MHI cohort has several important social implications for students, particularly those at the risk of repeated trauma (e.g., those engaging in high contact sports) and/or having a certain personality profile (such as higher psychopathy). In the absence of visceral feedback (underarousal), they may engage in greater risk-taking and anti-social behaviours, leading to unfavorable outcomes in the community and workplace. These individuals may be particularly at risk for social isolation due to deficient empathy and emotion processing; rendering them less capable of empathic compassion and socially-acceptable pragmatics; thereby impacting one's social interactions and engagement (i.e., at risk for social isolation or altered interpersonal success).

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APPENDIX A: STATISTICAL ANALYSES

Table 3

Summary of Means and Standard Deviations of Trials on the EPT with and without Problem Images

Behavioural Scale	Neutral-Neutral		Neutral-Negative		Negative-Negative		Negative-Neutral	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Trial 1				
Empathy								
With PI	3.23	1.25	3.24	1.33	6.77	1.39	6.65	1.40
Without PI	3.40	1.41	3.44	1.42	7.47	1.24	7.33	1.27
Arousal								
With PI	2.96	1.26	2.81	1.35	5.66	2.14	5.77	2.15
Without PI	3.05	1.31	2.89	1.37	5.75	2.20	5.84	2.24
Intensity								
With PI	2.88	1.15	2.83	1.17	6.60	1.29	6.66	1.32
Without PI	2.94	1.20	2.91	1.19	6.78	1.24	6.75	1.36
Valence								
With PI	4.86	1.01	5.07	1.01	1.87	0.89	1.97	0.92
Without PI	5.09	1.04	5.26	1.01	1.69	0.79	1.74	0.88

Behavioural Scale	Neutral-Neutral		Neutral-Negative		Negative-Negative		Negative-Neutral	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Trial 2				
Empathy								
With PI	3.05	1.44	5.85	1.32	7.82	1.06	3.65	1.56
Without PI	3.13	1.61	6.82	1.40	8.15	1.05	3.69	1.60
Arousal								
With PI	2.63	1.28	4.61	2.00	6.15	2.36	4.01	1.68
Without PI	2.72	1.35	4.50	2.00	6.23	2.43	4.02	1.75
Intensity								
With PI	2.45	1.12	5.18	1.47	7.44	1.19	4.29	1.41
Without PI	2.53	1.21	5.11	1.43	7.56	1.19	4.34	1.45
Valence								
With PI	5.15	1.11	2.45	1.11	1.44	0.74	4.24	1.41
Without PI	5.41	1.18	2.46	1.13	1.32	0.65	4.31	1.48

	Difference Scores							
Empathy								
With PI	-0.18	0.92	2.61	1.61	1.05	0.96	-3.00	1.96
Without PI	-0.27	0.97	3.38	1.72	0.68	0.76	-3.64	1.85
Arousal								
With PI	-0.33	0.76	1.80	1.59	0.49	0.66	-1.76	1.57
Without PI	-0.33	0.82	1.61	1.57	0.49	0.72	-1.82	1.66
Intensity								
With PI	-0.43	0.71	2.36	1.37	0.83	0.68	-2.38	1.34
Without PI	-0.41	0.79	2.20	1.37	0.78	0.70	-2.41	1.47
Valence								
With PI	0.29	0.70	-2.62	1.33	-0.43	0.58	2.27	1.35
Without PI	0.32	0.79	-2.81	1.26	-0.37	0.61	2.57	1.62

Note. M = mean; *SD* = standard deviation; PI = problem images

Table 4.

Summary of results for the 2 way (Image Type: Neutral, Negative) repeated measures ANOVAs conducted to examine the effectiveness of images used in the EPT across the behavioural scales

Behavioural Scale	df, df_{error}	*F*	*P*	η_p^2
Empathy	1, 99	560.10	< .001	.85
Arousal	1, 99	204.49	< .001	.67
Intensity	1, 99	736.67	< .001	.88
Pleasantness	1, 99	951.51	< .001	.91

Table 5

Summary of results for the interaction term in the 2 (Image Type: Neutral, Negative) X 2 (Context: Confirming, Contrasting) repeated-measures ANOVAs conducted to examine the effectiveness of the scenarios used in Trial 2 of the EPT across the behavioural scales

Behavioural Scale	df, df_{error}	F	P	η_p^2
Empathy	1, 99	538.93	< .001	.85
Arousal	1, 99	125.83	< .001	.56
Intensity	1, 99	489.32	< .001	.83
Pleasantness	1, 99	505.25	< .001	.84

Table 8

Summary of Results of the Hierarchical Multiple Regression Analyses Predicting Empathy Ratings while viewing images on Trial 1 of the EPT from the Injury Severity Index

Predictor	β	p	r	F	R^2	ΔR^2
Overall Empathy Ratings						
Model 1				0.20	.00	.00
Gender	-.05	.653	-.05			
Model 2				1.74	.03	.03
Psychopathy	-.21	**.074**	-.18*			
Model 3				3.16*	.09	.06
Severity Index	-.24	**.018**	-.24**			
Neutral Images						
Model 1				2.06	.02	.02
Gender	.14	.155	.14†			
Model 2				1.12	.02	.00
Psychopathy	-.05	.655	.03			
Model 3				1.62	.05	.02
Severity Index	-.17	.111	-.12			
Negative Images						
Model 1				4.75*	.05	.05
Gender	-.22	**.03**	-.22*			
Model 2				5.04**	.10	.05
Psychopathy	-.25	**.03**	-.30**			

Model 3				4.64**	.13	.03
Severity Index	-.19	**.06**	-.23*			

Note. N = 99; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; ** $p < .01$, * $p < .05$, † $p < .10$.

Table 9

Summary of Results of the Hierarchical Multiple Regression Analyses Predicting Arousal Ratings while viewing images on Trial 1 of the EPT from the Injury Severity Index

Predictor	β	p	r	F	R^2	ΔR^2
Overall Arousal Ratings						
Model 1				2.38	.02	.02
Gender	-.15	.126	-.15†			
Model 2				1.28	.02	.00
Psychopathy	-.05	.659	-.12			
Model 3				3.29*	.09	.07
Severity Index	-.27	**.009**	-.29**			
Neutral Images						
Model 1				0.07	.00	.02
Gender	.03	.795	.03			
Model 2				0.33	.01	.01
Psychopathy	.09	.444	.08			
Model 3				0.94	.03	.02
Severity Index	-.15	.145	-.13			

			Negative Images			
Model 1				5.18*	.05	.05
Gender	-.22	**.03**	-.22*			
Model 2				3.13*	.06	.01
Psychopathy	-.12	.30	-.23*			
Model 3				5.04**	.14	.08
Severity Index	-.29	**.01**	-.33***			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; ** $p < .01$, * $p < .05$.

Table 10

Summary of Results of the Hierarchical Multiple Regression Analyses Predicting Intensity Ratings while viewing images on Trial 1 of the EPT from the Injury Severity Index

Predictor	β	p	r	F	R^2	ΔR^2
			Overall Intensity Ratings			
Model 1				0.24	.00	.00
Gender	-.05	.622	-.05			
Model 2				0.74	.02	.02
Psychopathy	-.13	.268	-.12			
Model 3				0.87	.03	.01
Severity Index	-.11	.294	-.13			
			Neutral Images			

Model 1						
Gender	.08	.459	.08	0.55	.01	.01
Model 2						
Psychopathy	-.00	.964	.03	0.28	.01	.00
Model 3						
Severity Index	-.11	.306	-.08	0.54	.02	.01
			Negative Images			
Model 1				1.95	.02	.02
Gender	-.14	.165	-.14†			
Model 2				2.34	.05	.03
Psychopathy	-.19	.104	-.21*			
Model 3				1.70	.05	.00
Severity Index	-.07	.125	-.12			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{*}p < .05$. $^{\dagger}p < .10$

Table 11

Summary of Results of the Hierarchical Multiple Regression Analyses Predicting Pleasantness Ratings while viewing images on Trial 1 of the EPT from the Injury Severity Index

Predictor	β	p	r	F	R^2	ΔR^2
Overall Pleasantness Ratings						
Model 1				0.27	.00	.00
Gender	.05	.606	.05			
Model 2				0.31	.01	.00
Psychopathy	-.07	.553	-.03			
Model 3				0.21	.01	.00
Severity Index	.00	.943	.00			
Neutral Images						
Model 1						
Gender	-.01	.923	-.01	0.01	.00	.00
Model 2						
Psychopathy	-.20	.092	-.15†	1.46	.03	.03
Model 3						
Severity Index	-.02	.856	-.04	0.97	.03	.00
Negative Images						
Model 1				1.22	.01	.01
Gender	.11	.273	.11			
Model 2				1.56	.03	.02

Psychopathy	.16	.173	.17*			
Model 3				1.03	.03	.00
Severity Index	.01	.895	.06			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{*}p < .05$. $^{\dagger}p < .10$

Table 12

Summary of Hierarchical Regression Analyses Predicting Empathy Change Scores across Different Conditions of the EPT from the Injury Severity Index

Predictor	B	p	r	F	R^2	ΔR^2
			Neutral-Neutral			
Model 1				3.79†	.04	.04
Gender	.19	**.05**	.19*			
Model 2				2.09	.04	.00
Psychopathy	.07	.52	.15†			
Model 3				1.79	.05	.01
Severity Index	.11	.28	.16†			
Predictor	B	p	r	F	R^2	ΔR^2
			Neutral-Negative			
Model 1				4.76*	.05	.05
Gender	-.22	**.03**	-0.22*			
Model 2				3.29*	.06	.02
Psychopathy	-.15	.19	-0.22*			
Model 3				2.17*	.06	.00

Severity Index	.00	.98	-.07			
Predictor	B	p	r	F	R^2	ΔR^2
			Negative-Negative			
Model 1				2.42	.02	.02
Gender	.16	.12	.16†			
Model 2				1.31	.03	.00
Psychopathy	-.05	.64	.04			
Model 3				1.24	.04	.01
Severity Index	.11	.30	.14†			
Predictor	B	p	r	F	R^2	ΔR^2
			Negative-Neutral			
Model 1				2.99†	.03	.03
Gender	-.17	**.09**	-.17*			
Model 2				2.53†	.05	.02
Psychopathy	-.16	.16	-.21*			
Model 3				1.72	.05	.00
Severity Index	-.04	.70	-.10			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{*}p < .05$, $^{\dagger}p < .1$.

Table 13

Summary of Hierarchical Regression Analyses Predicting Arousal Change Scores across Different Conditions of the EPT from the Injury Severity Index

Predictor	β	p	r	F	R^2	ΔR^2
			Neutral-Neutral			
Model 1				2.04	.02	.02
Gender	.14	.16	.14†			
Model 2				1.56	.03	.01
Psychopathy	.12	.30	.16†			
Model 3				1.03	.03	.00
Severity Index	.02	.88	.06			
Predictor	β	p	r	F	R^2	ΔR^2
			Neutral-Negative			
Model 1				4.05*	.04	.04
Gender	-.20	**.05**	-.20*			
Model 2				3.46*	.07	.03
Psychopathy	-.19	.10	-.24**			
Model 3				3.62*	.10	.03
Severity Index	-.19	**.06**	-.25**			
Predictor	β	p	r	F	R^2	ΔR^2
			Negative-Negative			
Model 1				.63	.01	.01
Gender	-.08	.43	-.08			

Model 2				.72	.01	.01
Psychopathy	-.11	.37	-.12			
Model 3				.64	.02	.01
Severity Index	-.07	.48	-.10			
Predictor	β	p	r	F	R^2	ΔR^2
			Negative-Neutral			
Model 1				2.40	.02	.02
Gender	-.15	.12	-.15†			
Model 2				2.44†	.05	.02
Psychopathy	-.18	.12	-.21*			
Model 3				1.99	.06	.01
Severity Index	-.11	.30	-.16†			

Note. N = 100; β represents standardized regression coefficients, *p* represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{**}p < .01$, $^{*}p < .05$, $^{\dagger}p < .1$

Table 14

Summary of Hierarchical Regression Analyses Predicting Intensity Change Scores across Different Conditions of the EPT from the Injury Severity Index

Predictor	B	p	r	F	R^2	ΔR^2
			Neutral-Neutral			
Model 1				5.67*	.05	.05
Gender	.23	**.02**	.23*			
Model 2				3.37*	.07	.01
Psychopathy	.12	.30	.21*			
Model 3				2.72*	.08	.01
Severity Index	.12	.24	.18*			
Predictor	B	p	r	F	R^2	ΔR^2
			Neutral-Negative			
Model 1				1.12	.01	.01
Gender	-.11	.29	-.11			
Model 2				1.68	.03	.02
Psychopathy	-.17	.14	-.18*			
Model 3				1.19	.04	.00
Severity Index	.05	.63	.00			
Predictor	B	p	r	F	R^2	ΔR^2
			Negative-Negative			
Model 1				.72	.01	.01
Gender	.09	.40	.09			

Model 2				1.97	.04	.03
Psychopathy	-.21	**.08**	-.11			
Model 3				1.62	.05	.01
Severity Index	.10	.33	.10			
Predictor	B	p	r	F	R^2	ΔR^2
			Negative-Neutral			
Model 1				.27	.00	.00
Gender	-.05	.60	-.05			
Model 2				2.22	.04	.04
Psychopathy	-.24	**.04**	-.20*			
Model 3				3.20*	.09	.05
Severity Index	.23	**.03**	.17*			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{*}p < .05$, $^{\dagger}p < .1$.

Table 15

Summary of Hierarchical Regression Analyses Predicting Pleasantness Change Scores across Different Conditions of the EPT from the Injury Severity Index

Predictor	B	P	r	F	R^2	ΔR^2
			Neutral-Neutral			
Model 1				.50	.01	.01
Gender	-.07	.48	-.07			
Model 2				.57	.01	.01
Psychopathy	-.09	.43	-.11			
Model 3				.80	.02	.01
Severity Index	-.12	.26	-.14†			
Predictor	B	P	r	F	R^2	ΔR^2
			Neutral-Negative			
Model 1				.82	.01	.01
Gender	-.09	.37	-.09			
Model 2				2.21	.04	.04
Psychopathy	-.22	**.06**	-.21*			
Model 3				1.62	.05	.00
Severity Index	.07	.50	.02			
Predictor	B	P	r	F	R^2	ΔR^2
			Negative-Negative			
Model 1				.03	.00	.00
Gender	-.02	.86	-.02			

Model 2				.73	.01	.01
Psychopathy	-.14	.24	-.11			
Model 3				.67	.02	.01
Severity Index	.08	.45	.06			
Predictor	B	P	r	F	R^2	ΔR^2
			Negative-Neutral			
Model 1				.45	.00	.00
Gender	.07	.51	.07			
Model 2				.45	.01	.00
Psychopathy	-.08	.50	-.02			
Model 3				.71	.02	.01
Severity Index	.12	.27	.12			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{*}p < .05$, $^{\dagger}p < .1$

Table 16

Summary of results for the 2 (Head Injury: No MHI, MHI) x 2 (Psychopathy: Lower, Higher) between subjects ANOVA assessing average pulse frequency at baseline in male subjects

Source	df_{effect}, df_{error}	*F*	*p*	η_p^2
Head Injury	1, 39	0.02	.886	<.01
Psychopathy	1, 39	0.43	.515	.01
Head Injury x Psychopathy	1, 39	0.88	.354	.02

Table 17

Summary of results for the 2 (Image Type: Neutral, Negative) x 2 (Head Injury: No MHI, MHI) x 2 (Psychopathy: Lower, Higher) mixed model ANOVA assessing average pulse frequency while viewing images on Trial 1 in male subjects

Source	df_{effect}, df_{error}	*F*	*p*	η_p^2
Within Subjects effects				
Image Type	1, 39	1.14	.293	.03
Image Type x Head Injury	1, 39	0.51	.480	.01
Image Type x Psychopathy	1, 39	0.23	.636	.01
Image Type x Head Injury x Psychopathy	1, 39	1.54	.223	.04
Between Subjects effects				
Head Injury	1, 39	0.49	.489	.01
Psychopathy	1, 39	0.51	.509	.01
Head Injury x Psychopathy	1, 39	0.50	.485	.01

Table 18

Summary of results for the 2 (Image Type: Neutral, Negative) x 2 (Head Injury: No MHI, MHI) x 2 (Psychopathy: Lower, Higher) mixed model ANOVA assessing average change in pulse frequency from baseline while viewing images on Trial 1 of the EPT in male subjects

Source	df_{effect}, df_{error}	F	p	η_p^2
Within Subjects effects				
Image Type	1, 39	4.87	.033	.11
Image Type x Head Injury	1, 39	0.05	.823	<.01
Image Type x Psychopathy	1, 39	0.39	.537	.01
Image Type x Head Injury x Psychopathy	1, 39	1.67	.205	.04
Between Subjects effects				
Head Injury	1, 39	0.44	.511	.01
Psychopathy	1, 39	0.03	.869	<.01
Head Injury x Psychopathy	1, 39	0.42	.520	.01

Note. Box's M test was significant (p = .041) violating the assumption of equality of covariance matrices; Greenhouse-Geisser[G-G] corrections were used.

Table 19

Summary of Hierarchical Regression Analyses Predicting Participants' change in pulse frequency from baseline while viewing images on Trial 1 of the EPT from the Injury Severity Index

Predictor	B	p	r	F	R^2	ΔR^2
			Neutral Images			
Model 1				1.19	.01	.01
Gender	.11	.28	.11			
Model 2				1.54	.03	.02
Psychopathy	.16	.17	.18*			
Model 3				3.40*	.10	.07
Severity Index	-.27	**.01**	-.21*			
Predictor	B	p	r	F	R^2	ΔR^2
			Negative Images			
Model 1				.27	.00	.00
Gender	.05	.61	.05			
Model 2				1.55	.03	.03
Psychopathy	.20	.10	.18*			
Model 3				2.33†	.07	.04
Severity Index	-.21	**.05**	-.16†			

Note. N = 94; β represents standardized regression coefficients, *p* represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; $^{*}p < .05$, $^{\dagger}p < .1$

Table 20

Summary of Hierarchical Regression Analyses predicting scores on the Affective Empathy Factor of the QCAE and its constituent subscales from Psychopathy and the Injury Severity Index

Predictor	B	p	r	F	R^2	ΔR^2
Affective Empathy Factor						
Model 1				24.77***	.20	.20
Gender	-.45	**.00**	-.45***			
Model 2				14.25***	.23	.03
Psychopathy	-.19	**.08**	-.37***			
Model 3				10.30***	.24	.02
Severity Index	-.13	.15	-.26**			
Predictor	B	p	r	F	R^2	ΔR^2
Affective Empathy Subscale: Proximal Responsivity						
Model 1				8.88**	.08	.08
Gender	-.29	**.00**	-.29**			
Model 2				11.09***	.19	.10
Psychopathy	-.37	**.00**	-.42***			
Model 3				7.68***	.19	.01
Severity Index	-.09	.35	-.19*			
Predictor	B	p	r	F	R^2	ΔR^2
Affective Empathy Subscale: Emotion Contagion						
Model 1				15.33***	.14	.14
Gender	-.37	**.00**	-.37***			
Model 2				7.59**	.14	.00

Psychopathy	-.01	.94	-.19*			
Model 3				5.80**	.15	.02
Severity Index	-.14	.16	-.23*			
Predictor	B	p	r	F	R^2	ΔR^2
Affective Empathy Subscale: Peripheral Responsivity						
Model 1				12.55**	.11	.11
Gender	-.34	**.00**	-.34***			
Model 2				6.41**	.12	.00
Psychopathy	-.07	.56	-.22*			
Model 3				4.35**	.12	.00
Severity Index	-.06	.57	-.15†			

Note. N = 100; β represents standardized regression coefficients, p represents significance of predictors based on their corresponding t-tests, r represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; *** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .10$.

Table 21

Summary of Hierarchical Regression Analyses predicting scores on the Cognitive Empathy Factor of the QCAE and its constituent subscales from Psychopathy and the Injury Severity Index

Predictor	B	p	r	F	R^2	ΔR^2
Cognitive Empathy Factor						
Model 1				.42	.00	.00
Gender	.07	.52	.07			
Model 2				1.95	.04	.03
Psychopathy	-.22	**.07**	-.13			
Model 3				2.78*	.08	.04
Severity Index	-.21	**.04**	-.20*			
N	100					
Predictor	B	p	r	F	R^2	ΔR^2
Cognitive Empathy Subscale: Online Simulation						
Model 1				.05	.00	.00
Gender	.02	.82	.02			
Model 2				6.28**	.12	.12
Psychopathy	-.39	**.00**	-.28**			
Model 3				6.08**	.16	.05
Severity Index	-.22	**.03**	-.21*			
N	99					
Predictor	B	p	r	F	R^2	ΔR^2
Cognitive Empathy Subscale: Perspective Taking						

Model 1				.51	.01	.01
Gender	.07	.48	.07			
Model 2				.26	.01	.00
Psychopathy	.01	.95	.04			
Model 3				1.68	.05	.05
Severity Index	-.22	**.04**	-.18*			
N	98					

Note. β represents standardized regression coefficients, *p* represents significance of predictors based on their corresponding *t*-tests, *r* represents correlation coefficient between predictor and criterion, R^2 represents total variance, ΔR^2 represents change in variance; ** $p < .01$, * $p < .05$.

APPENDIX B: RESEARCH ETHICS CLEARANCE

Reviewer Disposition

(For REB Use Only) ► File #:_____ Reviewers:_____ Due Date:_____

Decision: Accepted as is ☐ Approval Pending Revision ☐ Clarification Required ☐

Resubmission ☐ Full Review ☐ Withhold Approval ☐

Brock University Research Ethics Board (REB)

Application for Ethical Review of Research Involving Human Participants

If you have questions about or require assistance with the completion of this form,

please contact the Research Ethics Office at (905) 688-5550 ext. 3035, or reb@brocku.ca.

Selecting a Research Ethics Board

Files will be allocated to one of two REB panels based upon the type of research to be undertaken.

If your research involves any of the following, submit to the Bioscience Research Ethics Board (BREB):

- physiological measures such as EEGs, heart rate, GSR, temperature, blood pressure, respiration, vagal tone, x-rays, MRIs, CT or PET scans;
- ingestion or other use of food, beverages, food additives, or drugs, including alcohol and tobacco;
- medical techniques or therapies, including experimental medical devices;

- physical exertion beyond normal walking;
- physical movement in participants who have medical vulnerabilities (e.g., spinal cord injury, osteoporosis);
- human biological materials (e.g., tissues, organs, blood, plasma, skin, serum, DNA, RNA, proteins, cells, hair, nail clippings, urine, saliva, bodily fluids);
- interventions with the potential for physiological effects (e.g., diet, exercise, sleep restriction); and/or
- use of medical or official health records (e.g., hospital records).

If none of the above points are characteristic of your research, submit to the Social Science Research Ethics Board (SREB)

Indicate which REB panel is appropriate for this application:

☒ **Bioscience (BREB)** **OR** ☐ **Social Science (SREB)**

DOCUMENT CHECKLIST **3 complete sets of the following documents (one original + 2 copies)**	

	✓ if applicable
Recruitment Materials • Letter of invitation • Verbal script • Telephone script • Advertisements (newspapers, posters, SONA) • Electronic correspondence guide	☐ ☐ ☐ ☒ ☐
Consent Materials • Consent form • Assent form for minors • Parental/3rd party consent • Transcriber confidentiality agreement	☒ ☐ ☐ ☐
Data Gathering Instruments • Questionnaires • Interview guides • Tests	☒ ☐ ☒
Feedback Letter	☒
Letter of Approval for research from cooperating organizations, school board(s), or other institutions	☐
Any previously approved protocol to which you refer	☐
Request for use of human tissue sample in research Please Note: this form is required for all research projects involving human tissue, bodily fluids, etc.	☐
Signed Application Form	☒

Return your completed application and all accompanying material **in triplicate** to the

Research Ethics Office in MacKenzie Chown D250A.

Handwritten Applications will ***not*** be accepted

SIGNATURES

PLEASE NOTE: The title "principal investigator" designates the person who is "in charge" of the research. In this position, the principal investigator is assumed to have the abilities to supervise other researchers, be responsible for the financial administration of the project, have the authority to ensure that appropriate guidelines and regulations are followed, and be competent to conduct the research in the absence of faculty supervision. The restriction of the term "principal investigator" to faculty or post-doctoral fellows does not have implications for ownership of intellectual property or publication authorship.

Given the above consideration, **a student cannot be identified as a "principal investigator"**. However, for the purpose of recognizing a student's leadership role in the research, a faculty member may designate a "principal *student* investigator" below.

INVESTIGATORS:

Please indicate that you have read and fully understand all ethics obligations by checking the box beside each statement and signing below.

☒ I have read Section III: 8 of Brock University's Faculty Handbook pertaining to Research Ethics and agree to comply with the policies and procedures outlined therein.
☒ I will report any serious adverse events (SAE) to the Research Ethics Board (REB).
☒ Any additions/changes to research procedures after approval has been granted will be submitted to the REB.
☒ I agree to request a renewal of approval for any project continuing beyond the expected date of completion or for more than one year.
☒ I will submit a final report to the Office of Research Services once the research has been completed.
☒ I take full responsibility for ensuring that all other investigators involved in this research follow the protocol as outlined in this application.

Principal Investigator

Signature _____ Date: _____

Principal Student Investigator (optional)

Signature _____ Date: _____

Co-Investigators:

Signature _____ Date: _____

Signature _____ Date: _____

FACULTY SUPERVISOR:

Please indicate that you have read and fully understand the obligations as faculty supervisor listed below by checking the box beside each statement.

☒ I agree to provide the proper supervision of this study to ensure that the rights and welfare of all human participants are protected.
☒ I will ensure a request for renewal of a proposal is submitted if the study continues beyond the expected date of completion or for more than one year.
☒ I will ensure that a final report is submitted to the Office of Research Services.
☒ I have read and approved this application and proposal.

Signature _____ Date: _____

SECTION A – GENERAL INFORMATION

1. **Title of the Research Project:** Individual Differences in Attitudes and Social Decision Making

2. **Investigator Information:**

	Name	**Position (e.g., faculty, student, visiting professor)**	**Dept./Address**	**Phone No.**	**E-Mail**
Principal Investigator	Dr. Dawn Good	Faculty	Department of Psychology and Centre for Neuroscience	(905) 688-5550 x 3869	Dawn.Good@brocku.ca
Principal Student Investigator					
Co-Investigator(s)	Tanvi Sharan Jennifer Kerlew	Master's student Undergraduate Thesis Student	Department of Psychology	(905) 688-5550 x 3869, 3556	ts05jo@brocku.ca jk07cv@brocku.ca

	Troy Hansen Lisa Lam	Undergraduate Thesis Student Student			th08tp@brocku.ca ll05oq@brocku.ca
Faculty Supervisor(s)					

3. **Proposed Date of commencement:** ☒ upon approval, OR ☐ other. Please provide date **(dd/mm/yyyy)** _____

Proposed Date of completion (dd/mm/yyyy): 31/12/2012

4. **Indicate the location**(s) where the research will be conducted:

Brock University	☒
Community Site	☐ Specify _____
School Board	☐ Specify _____
Hospital	☐ Specify _____
Other	☐ Specify _____

5. **Other Ethics Clearance/Permission:**

(a) Is this a multi-centered study? ☐ **Yes** ☒ **No**

(b) Has any other University Research Ethics Board approved this research? ☐ **Yes** ☒ **No**

If **YES**, there is no need to provide further details about the protocol **at this time,** provided that **all** of the following information is provided:

Title of the project approved elsewhere: _____

Name of the Other Institution: _____

Name of the Other Board: _____

Date of the Decision: _____

A contact name and phone number for the other Board: _____

Please provide a copy of the application to the other institution together with all accompanying materials, as well as a copy of the clearance certificate / approval.

If **NO**, will any other University Research Ethics Board be asked for approval? ☐ **Yes** ☒ **No**

Specify University/College _____

(c) Has any other person(s) or institutions granted permission to conduct this research? ☐ **Yes** ☒ **No**

If yes, specify (e.g., hospital, school board, community organization, proprietor) **provide details and attach any relevant documentation.** _____

If **NO**, will any other person(s) or institutions be asked for approval? ☐ **Yes** ☒ **No**

Specify (e.g., hospital, school board, community organization, proprietor) _____

6. **Level of the Research:**

☒ Undergraduate Thesis	☒ Masters Thesis/Project	☐ Ph.D
☐ Post Doctorate	☐ Faculty Research	☐ Administration
☐ Undergraduate Course Assignment (specify course) _____	☐ Graduate Course Assignment (specify) _____	☐ Other (specify course) _____

7. **Funding of the Project:**

(a) Is this project currently being funded ☐ **Yes** ☒ **No**

(b) If **No**, is funding being sought ☐ **Yes** ☐ **No**

If Applicable:

(c) Period of Funding (dd/mm/yyyy): From: _____ To: _____

(d) Agency or Sponsor (funded or applied for)

☐ CIHR ☐ NSERC ☐ SSHRC ☐ Other (specify): _____

(e) Funding / Agency File # (**not** your Tri-Council PIN) _____

8. **Conflict of Interest:**

(a) Will the researcher(s), members of the research team, and/or their partners or immediate family members receive any personal benefits related to this study – Examples include financial remuneration, patent and ownership, employment, consultancies, board membership, share ownership, stock options. Do not include conference and travel expense coverage, possible academic promotion, or other benefits which are integral to the general conduct of research.

☐ **Yes** ☒ **No**

If **Yes**, please describe the benefits below.

(b) Describe any restrictions regarding access to or disclosure of information (during or at the end of the study) that the sponsor has placed on the investigator(s).

N/A

SECTION B – SUMMARY OF THE PROPOSED RESEARCH

9. **Rationale:**

Briefly describe the purpose and background rationale for the proposed project, as well as the hypothesis(es)/research question(s) to be examined.

The ability to understand and respond to the emotional experiences of another individual is a core aspect of social interaction, and a deficit in this skill can negatively affect the individual's ability to integrate with society. One's capacity to consider another's emotional status is often described as one's capacity for empathy. Further, a manner by which this naivety is expressed can be observed through one's social judgement of, and towards, others (e.g., prejudice).

Empathy has been described as consisting of two primary components: cognitive empathy and affective or emotional empathy. Cognitive empathy is the ability to take the perspective of another individual, while affective empathy refers to sharing in the emotional experiences of another individual (Smith, 2006). Research has shown that two specific groups, psychopaths and individuals with a traumatic brain injury (TBI) demonstrate deficits in their empathic ability (Blair, 2005; Shamay-Tsoory, Tomer, Goldsher, Berger, & Aharon-Peretz, 2004). Individuals who score high on measures of interpersonal manipulation (one of the characteristics associated with subclinical and clinical psychopathic behavior – reflecting an aspect of 'cognitive' empathy) produce lower scores on measures of emotional empathy and demonstrate difficulties maintaining social relationships. Individuals with a mild head injury (MHI – a mild form of TBI) also have difficulty maintaining social relationships and have been shown to be unable to consider another's emotional status and respond less well to social affective cues (e.g., facial expression). Further, individuals with MHI and TBI are physiologically underaroused (e.g., on measures of electrodermal activity – EDA, or heart rate – HR) relative to their cohort implicating a difference in their emotional response to various stimuli (e.g., van Noordt & Good, 2010).

The ventromedial prefrontal cortex (VMPFC) has been implicated in the regulation of emotional arousal and its interaction with cognition, and ultimately emotional empathy. In contrast, cognitive empathy has been linked to the dorsolateral PFC (DLPFC) and lateral orbitofrontal cortex (LOFC), an

area of the brain associated with evaluation and rational cognition. Whereas research has found that psychopathy is associated with altered VMPFC function, TBI involves more diffuse injury to the orbitofrontal cortex including the VMPFC, as well as LOFC and the DLPFC (Blair, 2005). Traumatic injuries to the head typically impact these areas due to their vulnerable proximity to the bony protuberances of the frontal cranium.

The VMPFC and LOFC have also been implicated in social decision-making (e.g., in the form of social choices and judgments); that is, cognitive decisions are often influenced by, and altered, as a function of emotional/physiological input, particularly in situations of uncertainty, and can lead to risk-taking behaviour and behaviour reflecting social abruptness and insensitivity (e.g., Johnson & Good, 2011). As a result, an inability to consider another's circumstance or emotional experience can be witnessed in his/her social judgement of another (i.e., prejudice) and, thereby, limits one's capacity for social inclusion and integration.

Therefore, the purpose of this study is to investigate individual differences (MHI status, psychopathy) on one's social judgment of others and capacity for perspective taking/empathy. We expect individuals with higher scores on subcomponents of subclinical psychopathy to demonstrate less emotional, relative to cognitive, empathy; and that this finding will interact with MHI status. Further, given that empathy may mediate one's judgement of others, it is expected that psychopathy, and separately, MHI status, will predict one's perceived prejudice.

References

Blair, R. J. R. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and Cognition, 14*, 698-718. doi:10.1016/j.concog.2005.06.004

Johnson, S., & Good, D. (2011, May). Attitudes towards ABI: Gaining insight into the factors contributing to prejudice towards the ABI community. Poster session presented at the 31st Annual Southern Ontario Neuroscience Association Meeting, Guelph, Ontario.

McDonald, S. (2000). Putting communication disorders in context after traumatic brain injury. *Aphasiology, 14*, 339-347. doi: 10.1080/026870300401397

Shamay-Tsoory, S. G., Tomer, R., Goldsher, D., Berger, B. D., & Aharon-Peretz, J. (2004) Impairment in cognitive and affective empathy in patients with brain lesions: Anatomical and cognitive correlates. *Journal of Clinical and Experimental Neuropsychology, 26*, 1113-1127. doi: 10.1080/1380339049 0515531

Smith, A. (2006). Cognitive empathy and emotional empathy in human behavior and evolution. *The Psychological Record, 56*, 3-21.

van Noordt, S., & Good, D. (2010). Investigating the relationship between mild head injury, physiological arousal, and neuropsychological performance: Is there residual orbitofrontal cortex dysfunction with respect to processing social and emotional information? *Frontiers in Human Neuroscience. Conference Abstract: The 20th Annual Rotman Research Institute Conference, The Frontal Lobes.*

10. **Methods:**

Are any of the following procedures or methods involved in this study? Check **all** that apply**.**

- ☐ Questionnaire (mail)
- ☐ Questionnaire (email/web)
- ☒ Questionnaire (in person)
- ☐ Interview(s) (telephone)
- ☐ Interview(s) (in person)
- ☐ Secondary Data
- ☒ Computer-administered tasks
- ☐ Focus Groups
- ☐ Journals/Diaries/Personal Correspondence
- ☐ Audio/video taping specify)
- ☐ Observations
- ☐ Invasive physiological measurements (e.g. venipuncture, muscle biopsies)
- ☒ Non-invasive physical measurement (e.g., exercise, heart rate, blood pressure)
- ☐ Analysis of human tissue, body fluids, etc. (Request for Use of Human Tissue Sample must be completed and attached)
- ☐ Other: (specify) _____

Describe sequentially, and in detail, all of the methods involved in this study and all procedures in which the research participants will be involved (paper and pencil tasks, interviews, questionnaires, physical assessments, physiological tests, time requirements, etc.)

Attach a copy of all questionnaire(s), interview guides or other test instruments. If reference is made to previous protocols, please provide copies of relevant documentation.

Advertisements (see Appendix) will recruit undergraduate university students to participate in a study investigating individual differences in attitudes and social decision making. Participants will be tested individually. After informed consent has been obtained, subjects will be assisted (as needed) in applying noninvasive physiological apparatus (i.e., respiratory bands across the chest and

abdomen for respiration, electrodes on index and fourth finger for EDA (i.e., electrodermal activity of skin response), and a pulse oximeter for heart rate) for later recording throughout the study session using Polygraph Professional equipment. Participants will be presented with a set of 24 pictures (12 negative, 12 neutral) with accompanying context scenarios (6 negative, 6 neutral) and asked to rate their perceived empathy (9 point scale: 1 = no empathy to 9 = Significant empathy) towards a to-be-judged target/agent in the picture (see Appendix for the materials described). After all pictures have been rated, participants will complete neuropsychological tests of cognitive ability (standardized WAIS–IV - Similarities, Matrix Reasoning; DKEFS – Trails Making 2 & 4) to verify their cognitive status (i.e., cognitive measures that demonstrate/measure the relative cognitive capacity or ability of each participant in terms of 'reasoning' through the Matrix Reasoning (for visuospatial information) and Similarities (for verbal information) task of an Intelligence test battery, as well as 'speed of processing' through the Trails task (that has both a visuospatial and verbal component) from an Exectutive Functioning test battery). Participants will then be presented with a second series of materials, consisting of 4 vignettes presenting social situations of individuals to-be-judged while manipulating behaviour presentation (2 depicting agents exhibiting socially disruptive behaviour, 2 with non-disruptive behaviour) and social familiarity (2 depicting a familiar agent, 2 depicting a non-familiar agent). Participants will then be asked to rate their attitude toward the target person/agent assessing their judgment of, and prejudice towards, that person. After the vignettes have been rated, the participants will complete a questionnaire package including a demographic questionnaire assessing MHI status, health, and personality (see Appendix). After the questionnaires are completed a brief interview (unstructured) will be conducted in order to gauge a better understanding of the individual's nature of injury (e.g., site of impact, force of impact). Participants will then be verbally debriefed and given a written debriefing form (see Appendix). They will be thanked for their participation. Overall, participation in this study (including time for acquisition of informed consent and debriefing procedures) will not exceed two hours.

Description of Neuropsychological Tests:

1. Trails:
   A timed paper and pen task designed to assess executive function including sustained attention, sequencing and, in particular, cognitive flexibility. The Trails is a connect the dots type task in which participants will be required to locate numbers and letters in an alternating sequence (as fast as possible) while keeping the ascending and alphabetical order constant (e.g., 1-A-2-B, etc). Response time and accuracy will be recorded.

   Delis, D.C., Kaplan, E., & Kramer, J.H. (2001). *Delis-Kaplan executive function system*. San

Antonio, TX: Psychological Corporation.

2. Similarities:
   A subset of the Verbal Comprehension Index of the Wechsler's Adult Intelligence Scale, Version IV (WAIS-IV), the Similarities task is designed to assess one's capacity for verbal reasoning. The participant will be presented with two words that represent common objects or concepts and asked to describe how they are similar (e.g., "In what way are an apple and a pear alike?")

   Wechsler, D. (2008). *Wechsler Adult Intelligence Scale—Fourth Edition.* San Antonio, TX: Pearson Assessment.

3. Matrix Reasoning
   A subset of the Perceptual Reasoning Index of the Wechsler's Adult Intelligence Scale, Version IV (WAIS-IV), the Matrix Reasoning task is designed to assess nonverbal abstract problem solving, inductive reasoning, and spatial reasoning. The participant will view an incomplete matrix or series and select a response option (from available alternatives) that completes the matrix or series.

   Wechsler, D. (2008). *Wechsler Adult Intelligence Scale—Fourth Edition.* San Antonio, TX: Pearson Assessment.

Note: Considering the protected nature of these tasks, they have not been appended to this application. These materials can be provided upon request from Dr. Dawn Good, Registered Clinical Psychologist, and must be returned upon review.

Description of Questionnaires (in order of administration):

1. The Attribution Questionnaire (AQ)- In order to measure prejudiced attitudes towards the agents in the scenarios (Phase 3 of study), an adapted version of the Attribution Questionnaire will be used. The AQ contains 20 items with six sub-scales measuring the

constructs of personal responsibility for injury beliefs, pity, anger, fear, willingness to help, and support for coercion-segregation.

Adapted from Corrigan, P., Markowitz, F.E., Watson, A., Rowan, D., & Kubiak, M.A. (2003). An attribution model of public discrimination towards persons with mental illness. *Journal of Health and Social Behavior, 44*, 162–179.

2. The Psychopathic Personality Inventory- Revised (PPI-R)- is a 154-item self-report measure of both global psychopathy and the component traits of psychopathy. The PPI-R assesses response styles relevant to primary or the "affective" traits of psychopathy (e.g., positive or negative impression management, random or careless responding) and can be used in both clinical (e.g., forensic) and nonclinical (e.g., student, community) settings.

   Lilienfeld, S. O., & Widows, M. (2005). *Psychopathic Personality Inventory-Revised professional manual.* Odessa, FL: PAR.

3. The Self-Report Psychopathy Scale (SRP-III): a 64-item scale which measures 4 components of psychopathy, namely Interpersonal Manipulation (e.g., "I think I could "beat" a lie detector"); erratic lifestyle (e.g., "I'm a rebellious person"); callous affect (e.g., "Most people are wimps"); and anti-social behavior (e.g., "I have never been arrested"). Participants will be asked to rate each item using a 5-point scale ranging from 1 (disagree strongly) to 5 (agree strongly). This Questionnaire was specifically developed for assessing psychopathy tendencies in university and non clinical populations and has good reliability and validity.

   Williams, K. M., Paulhus, D. L. & Hare, R. D. (2007). *Manual for SRPS.* Toronto, Ontario, Canada: Multi-Health Systems.

4. The Questionnaire of Cognitive and Affective Empathy (QCAE). The QCAE contains 31 items which are rated on a 4-point Likert scale from ranging from *strongly agree* to *strongly disagree*. The QCAE is broken down into 19 items which measure cognitive empathy (e.g. "I often get emotionally involved with my friends' problems") and 12 items which measure affective empathy (e.g. "I usually stay emotionally detached when watching a film").

   Reniers, R. L., Corcoran, R. Drake, R., Shryane, N. M. & Vollm, B. A. (2011). The QCAE: A Questionnaire of Cognitive and Affective Empathy. *Journal of Personality Assessment, 93*, 84–95.

5. Brock University Neuropsychology Cognitive Research Laboratory Everyday Living Questionnaire (ELQ) (2011): This questionnaire was designed to assess the participant's

demographic information such as sex, age, handedness, health status, emotional complaints etc. along with a detailed history of the nature of their head injury.

6. Daily Life Stressors Questionnaire (Item 69 in Questionnaire 8- ELQ (2011)): Assesses individuals' frequency of life stressors over the past 6 months. Some sample items include, "Death of a family member", "New Relationship".

   Adapted from Holmes, T. & Rahe, R. (1967). "Holmes-Rahe life changes scale". *Journal of Psychosomatic Research, 11*, 213-218.

7. Post-Concussive Checklist (Item 71 in Questionnaire 8- ELQ (2011)): Participants rate the frequency, intensity and duration for each of the symptoms presented, such as headache, memory problems, and dizziness, provided in the Post-Concussive Symptoms Checklist (PCSC) (Gouvier et al. 1992) on a 5-point scale ranging from 1(not all) to 5 (all the time).

   Gouvier, W.D., Cubic, B., Jones, G., Brantley, P., & Cutlip, Q. (1992). Postconcussion symptoms and daily stress in normal and head-injured college populations. *Archives of Clinical Neuropsychology, 7,* 193-211.

8. Level of Contact Questionnaire (Items 72-83 in Questionnaire 8- ELQ (2011)): A 12-item questionnaire used to determine the amount of prior contact that an individual has had with brain injury. Some sample items include: "I have wateched a movie or television show in which a character depicted a person with a brain injury"; "I have never observed a person that I was aware had a brain injury." The items are ranked from least intimate (score = 1) to most intimate (score = 12).

   Adapted from Corrigan, P., Edwards, A. B., Green, A., Diwan, S. L. & Penn, D. L. (2001). Prejudice, social distance, and familiarity with mental illness, *Schizophrenia Bulletin, 27,* 219-225.

11. **Professional Expertise/Qualifications:**

Does this procedure require professional expertise/recognized qualifications (e.g., registration as a clinical psychologist, first aid certification)?

☐ **Yes** specify: _____ ☒ **No**

If **YES**, indicate whether you, your supervisor, or any members of your research team have the professional expertise/recognized qualifications required? ☐ **Yes** ☐ **No**

12. **Participants:**

Describe the number of participants and any required demographic characteristics (e.g., age, gender).

80 undergraduate students from Brock University will be recruited to participate in the study. There will be no specific selection criteria and all students interested in participating would be invited.

13. **Recruitment:**

Describe how and from what sources the participants will be recruited, including any relationship between the investigator(s), sponsor(s) and participant(s) (e.g., family member, instructor-student; manager-employee).

Attach a copy of any poster(s), advertisement(s) and/or letter(s) to be used for recruitment.

Participants will be recruited for the study via the research pool at Brock University (SONA). Poster advertisements for the study will be posted throughout the university including the Psychology Research Board (see Appendix for poster) after ethics clearance is received by REB.

14. **Compensation:**

a) Will participants receive compensation for participation? ☒ **Yes** ☐ **No**

b) If yes, please provide details.

Participants will receive a maximum of 2 research credits for their participation. Each participant would receive credit at the rate of half a credit for every half hour of participation. No monetary compensation would be provided.

SECTION C – DESCRIPTION OF THE RISKS AND BENEFITS OF THE PROPOSED RESEARCH

15. **Possible Risks:**

1) Indicate if the participants might experience any of the following risks:

a) Physical risks (including any bodily contact, physical stress, or administration of any substance)?

☒ **Yes** ☐ **No**

b) Psychological risks (including feeling demeaned, embarrassed worried or upset, emotional stress)?

☒ **Yes** ☐ **No**

c) Social risks (including possible loss of status, privacy, and / or reputation)? ☐ **Yes** ☒ **No**

d) Are any possible risks to participants greater than those that the participants might encounter in their everyday life? ☐ **Yes** ☒ **No**

e) Is there any deception involved? ☒ **Yes** ☐ **No**

f) Is there potential for participants to feel obligated to participate or coerced into contributing to this research (because of regular contact between participants and the researcher, relationships that involve power-dynamics, etc.)? ☐ **Yes** ☒ **No**

2) If you answered **Yes** to any of 1a – 1f above, please explain the risk.

Physical risks-

Since we are interested in obtaining physiological responses of participants, a polygraph device will be used to assess participants' physiological arousal. Wearing this equipment may cause some minor discomfort to the participant during the course of the study. Although the physiological equipment is non-invasive, the application of electrodes may involve minimal bodily contact between the researcher and the participant. However, strict sanitary procedures would be followed (e.g., use of gloves, sanitized and disinfected equipment, etc.) and all equipment would be set-up in a non-invasive manner. All participants would be reminded that participation is completely voluntary, and if they feel uncomfortable at any point they may discontinue or choose to withdraw from the study without any penalty.

Psychological risks-

During the course of the study participants may experience emotional stress as some of the images used in the study are graphically explicit and depict mutilation, death and other disturbing scenarios. Although the content may cause emotional distress in some individuals, such emotional arousal is expected and pertinent to understanding the relationship between physiological arousal and empathy. Moreover, these images are no more emotionally charged than some of the situations commonly portrayed in popular films and novels. Participants will receive warning regarding the explicit nature of the materials prior to obtaining their consent. They would also be told that during the course of the study, if at any point they feel that they are unable to proceed or find the images too distressing, they may choose to withdraw without any penalty. Emergency contact information to the Counseling Services at Brock University will be provided in the debriefing statement in case the need arises.

Some of the statements used in questionnaires may involve participants to reflect on their past/current life and induce some negative affect/ anxiety. However, the levels of possible distress are no greater, and/or not unlike the everyday experiences as a student. Participants will be reminded that in case they feel uncomfortable, they may choose to omit answering a question/statement.

Participants might experience some mental stress during the completion of cognitive tests which are designed to test cognitive abilities such as problem solving, reasoning and attention. Participants may feel embarrassed and/or anxious as the complexity of tasks increases and may feel that their

intelligence/ academic competency is being assessed. Participants will be reminded that it is normal to not be able to complete all items and their performance is not reflective of their academic competency or intelligence. Moreover, the level of stress experienced is not expected to be greater than what students experience in everyday university settings.

Deception – While students are informed that 'Individual Differences' in personality and other variables will be investigated in this study, they are not specifically informed that a previous history of 'head injury' is of particular interest in our study – hence, a form of deception. The deception involved is one of 'omission'. This deception is necessary due to a phenomenon required in this research area in order to avoid subject-bias. Research on students and individuals with MHI cannot get published unless we do not disclose the aim of the study until it is completed.

See –

Suhr, J.A., Gunstad, J. (2002). "Diagnosis threat": The effect of negative expectations on cognitive performance in head injury. *Journal of Clinical and Experimental Neuropsychology, 24*(4), 448-457.

Suhr, J.A., Gunstad, J. (2005). Further exploration of the effects of "diagnosis threat" on cognitive performance in individuals with mild head injury. *Journal of the International Neuropsychological Society, 11*, 23-29.

Participants will be informed of this additional 'individual difference' at study completion during the debriefing process.

3) Describe how the risks will be managed and include the availability of appropriate medical or clinical expertise or qualified persons. Explain why less risky alternative approaches could not be used.

To manage physical risks - strict sanitary procedures would be followed (e.g., use of gloves, sanitized and disinfected equipment etc.) and all equipment would be set-up in a non-invasive manner. All participants would be reminded that participation is completely voluntary, and if they feel uncomfortable at any point they may discontinue or choose to withdraw from the study without any penalty.

To manage psychological risk - participants will receive warning regarding the explicit nature of the materials prior to obtaining consent. They would also be told that during the course of the study, if at any point they feel that they are unable to proceed or find the images too distressing, they may choose to withdraw without any penalty. Participants will be fully debriefed at the end of the study and should they feel that they have experienced any negative emotion (e.g., embarrassed, stress) or have been adversely affected as a result of their involvement in the study, they will be provided with information to counseling services and advised that they can contact Brock University Counseling Services for assistance - ST 400, (905)688-5550 Ext. 3240. They may also choose to contact the principal investigator, Dr. Dawn Good, to discuss their concerns.

Participants will also be advised that they can speak to a Research Ethics officer by contacting (905)688-5550 ext.3035 if they feel that their rights as a participant have been violated or if they have any concerns regarding the nature of the study.

16. **Possible Benefits:**

Discuss any potential direct benefits to the participants from their involvement in the project. Comment on the (potential) benefits to the scientific community/society that would justify involvement of participants in this study.

Direct benefits to participants: Participants may find the study enjoyable and gain insight into topics of psychology and brain injury. They will also gain some practical experience in a research setting.

Benefits to community/research: The findings from this study will further our understanding of the nature of brain injury particularly highlighting the enduring effects of MHI (e.g., concussion) and its relationship with decision making and arousal.

SECTION D – THE INFORMED CONSENT PROCESS

17. **The Consent Process:**

Describe the process that the investigator(s) will be using to obtain informed consent. Include a description of who will be obtaining the informed consent. If there will be no written consent form, explain why not.

For information about the required elements in the letter of invitation and the consent form, as well as samples, please refer to: http://www.brocku.ca/researchservices/forms/index.php

If applicable, attach a copy of the Letter of Invitation, the Consent Form, the content of any telephone script, and any other material that will be utilized in the informed consent process.

The researcher/research assistant would be acquiring written consent prior to starting the study. A written informed consent form (see Appendix) would be read out aloud to the participant detailing the procedure as well as potential risks/benefits associated with participation. They would be reminded of their rights as a participant and assured that their participation is completely voluntary and that they are free to withdraw at any point should they not wish to continue. After ensuring that the participant understands what the study entails, they will be required to sign 2 copies of the written consent forms (one for the participant and one for the records of the researcher).

18. **Consent by an authorized party:**

If the participants are minors or for other reasons are not competent to consent, describe the proposed alternative source of consent, including any permission form to be provided to the person(s) providing the alternative consent.

N/A

19. **Alternatives to prior individual consent:**

If obtaining individual participant consent prior to commencement of the research project is not appropriate for this research, please explain and provide details for a proposed alternative consent process.

N/A

20. **Feedback to Participants:**

Explain what feedback/ information will be provided to the participants after participation in the project. This should include a more complete description of the purpose of the research, and access to the results of the research. Also, describe the method and timing for delivering the feedback.

At the end of testing session, participants will be given a debriefing statement (see Appendix) and provided with a verbal description of the study. The purpose of the study will be elaborated during the debriefing session and any questions or concerns that the participant may have will be addressed. All participants will be informed that the data collected will be summarized (averaged) across the participants and findings from the study may be presented as a publishable report(s) and at conferences. Participants will be invited to view the results of the study by date of completion (September 1, 2012). Contact information for the principal and student investigators will be provided on the debriefing form (see Appendix) should the participant wish to contact the researchers at any time.

21. **Participant withdrawal:**

a) Describe how the participants will be informed of their right to withdraw from the project. Outline the procedures that will be followed to allow the participants to exercise this right.

Participation in this study is voluntary. Participants will be informed of their rights as a participant and their freedom to withdraw in the written informed consent form (see Appendix). Participants will be informed that they can choose to withdraw any time during the 2 hour experimental session in case they do not wish to continue. It will be explained that if the participant should choose to withdraw in between the testing session, they will receive research credit that is reflective of their participation to that point (i.e., half credit for every half hour of participation) and their data will be shredded and disposed of in a professional and confidential manner. Furthermore, they will be reminded of the services available that they can consult should they have any questions or concerns (Brock University Counseling Services; Research Ethics Officer).

b) Indicate what will be done with the participant's data should the participant choose to withdraw. Describe what, if any, consequences withdrawal might have on the participant, including any effect that withdrawal may have on participant compensation.

If participants choose to withdraw, the researcher will provide them with a written debriefing form (see

Appendix), and also answer any questions. If a participant withdraws at any time during the 2 hour experimental session, any data collected from him or her will be destroyed (shredded) and not used in data analysis. If the participant choosing to withdraw is receiving research participation credit, the length of the student's participation will be credited up to a maximum of two research participation hours.

SECTION E – CONFIDENTIALITY & ANONYMITY

***Confidentiality*:** information revealed by participants that holds the expectation of privacy. This means that all data collected will not be shared with anyone except the researchers listed on this application.

***Anonymity of data*:** information revealed by participants will not have any distinctive character or recognition factor, such that information can be matched **(even by the researcher)** to individual participants. Any information collected using audio-taping, video recording, or interview cannot be considered anonymous. **Please note that this refers to the anonymity of the data itself and <u>not</u> the reporting of results.**

22. Given the definitions above:

a) Will the data be treated as confidential? ☒ **Yes** ☐ **No**

b) Are the data anonymous? ☒ **Yes** ☐ **No**

c) Describe any **personal identifiers** that will be collected during the course of the research (e.g., participant names, initials, addresses, birth dates, student numbers, organizational names and titles etc.). Indicate how personal identifiers will be secured and if they will be **retained** once data collection is complete.

N/A

d) If any personal identifiers will be **retained** once data collection is complete, provide a comprehensive rationale explaining why it is necessary to retain this information, **including the retention of master lists that link participant identifiers with unique study codes and de-identified data.**

N/A

e) State who will have access to the data.

The Primary Investigator, Dr. Dawn Good, and the student investigators, Tanvi Sharan, Jennifer Kerlew Troy Hansen and Lisa Lam, as well as the research assistants associated with the NCR research lab will have access to the data (all of whom have signed confidentiality agreements).

f) Describe the procedures to be used to ensure anonymity of participants and/or confidentiality of data **both during the conduct of the research and in the release of its findings.**

To insure confidentiality, informed consent forms will be kept separate from the data collected from the participants. All data will be numerically coded to ensure confidentiality. No information that could potentially reveal a participant's identity will be used in discussion of or in the report of the findings.

Participants will be informed that all data collected will be kept strictly confidential in a locked, safe lab to which only the principal, student investigators and the research assistants will have access.

All researchers and research assistants accessing the data have signed confidentiality agreements.

g) If participant anonymity and/or confidentiality is not appropriate to this research project, explain, in detail, how all participants will be advised that data will not be anonymous or confidential.

Participants will be advised that they will be asked questions of clarification at the end of the study with respect to their 'background questionnaire' only. No other responses will be reviewed. However we acknowledge that the material will not be anonymous at this point. Even so, the data

will be maintained in data files in an anonymous and confidential manner (in a password protected electronic form). See clarification in the consent form.

h) Explain how written records, video/audio tapes, and questionnaires will be secured, and provide details of their final disposal or storage, including how long they will be secured and the disposal method to be used.

All raw data collected will be kept in a secure and locked cabinet in the NCR lab for a period of five years. After the five year period, data will be shredded and/or destroyed.

SECTION F -- SECONDARY USE OF DATA

23.

a) Is it your intention to reanalyze the data **for purposes other than described in this application**?

☐ **Yes** ☒ **No**

b) Is it your intention to allow the study and data to be reanalyzed by colleagues, students, or other researchers outside of the original research purposes? If this is the case, explain how you will allow your participants the opportunity to choose to participate in a study where their data would be distributed to others (state how you will contact participants to obtain their re-consent)

No, it is not our intention.

c) If there are no plans to reanalyze the data for secondary purposes and, yet, you wish to keep the data indefinitely, please explain why.

N/A

SECTION G -- MONITORING ONGOING RESEARCH

It is the investigator's responsibility to notify the REB using the "Renewal/Project Completed" form, when the project is completed or if it is cancelled.
http://www.brocku.ca/researchservices/forms/index.php

24. **Annual Review and Serious Adverse Events (SAE):**

a) **MINIMUM REVIEW REQUIRES THE RESEARCHER COMPLETE A "RENEWAL/PROJECT COMPLETED" FORM AT LEAST ANNUALLY**.

Indicate whether any additional monitoring or review would be appropriate for this project.

Additional review may be required for this project depending on the rate of subject recruitment, but it is intended for the study to be completed by September 1, 2012. REB will be notified when the final research report is completed.

***Serious adverse events** (negative consequences or results affecting participants) **must be reported** to the Research Ethics Officer and the REB Chair, **as soon as possible** and, in any event, no more than 3 days subsequent to their occurrence.

25. **COMMENTS**

If you experience any problems or have any questions about the Ethics Review Process at Brock University, please feel free to contact the Research Ethics Office at (905) 688-5550 ext 3035, or reb@brocku.ca

INDIVIDUAL DIFFERENCES IN ATTITUDES AND SOCIAL DECISION MAKING

Informed Letter of Consent

Dear Participant,

You are invited to participate in a study we are conducting to examine individual differences in attitudes and social decision making. This research is facilitated by Dr. Dawn Good, Tanvi Sharan, Jennifer Kerlew, Troy Hansen and Lisa Lam from the Neuropsychology Cognitive Research Lab at Brock University.

The current study involves three phases and will take approximately **2 hours** of your time. You will be awarded 0.5 research credits for every 0.5 hours of participation. As part of Phase I of the study, you will be presented with a set of images and will be asked to rate these images on your perceived level of empathy. Some of these images may be graphic, depicting scenarios that may be emotionally arousing and distressing. Following the ratings you will enter Phase II, as part of which you will complete a series of neuropsychological tests designed to assess aspects of working memory, attention and other measures of executive functioning. Please be advised that these tests are not an indicator of your intelligence or academic competency, and being unable to complete a task is expected and completely normal. Further, since we are interested in group responses, **individual scores** will **not** be analysed for the purposes of this study. Following the tests you will enter Phase III in which you will be presented with a number of vignettes and asked to rate your attitude toward the targeted agent. Since we are interested in examining how physiological arousal interacts with attitudes and decision making, you will be attached to non-invasive physiological equipment (i.e., respiratory bands for respiration, electrodes on index and fourth finger for EDA (i.e., electrodermal activity of skin response), and a pulse oximeter for heart rate) throughout the course of your participation. Please be advised that these measures are completely non-invasive and will be applied following strict sanitary protocol.

Additionally, you will be asked to complete a series of questionnaires asking you to rate yourself pertaining to single sentence descriptions on how you think and act in certain situations, how you make decisions, as well as personality differences. Please note that some of these questions may appear personal and sensitive in nature. You will also be asked to provide background information about yourself such as age, sex, and level of education. For this background questionnaire only, we will be reviewing a subset of the questions with you at the end of the experiment in the event that further clarification is required. While your responses for this questionnaire only will not be anonymous, they will remain confidential. In addition, all data from this, and all other aspects of the study, will be maintained anonymously and confidentially in a password protected electronic form. Upon completion of the study, the specific purpose of the experiment will be explained and you will be provided with a debriefing form. **If you have any concerns or are confused about any component of the study, you may ask the researcher questions throughout the experimental session**.

While it is crucial that you answer all questions as truthfully and sincerely as possible, your participation in this study is completely **voluntary** and you may choose to decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time during the 2 hour experimental session, and may do so without any penalty or loss of benefits to which you are entitled. Should you choose to withdraw during the experimental session, please inform the researcher and you will be credited research participation hours up to that point, and your data will be shredded and/or omitted from analyses. All data collected from this study will be numerically

coded in order to maintain confidentiality, with only the principal investigator, co-investigators and research assistants having access to your data. No personal identifiers will be used during data collection, and all information will be stored securely and retained for a period of five years, after which it will be destroyed.

Although there are no invasive risks associated with participation in this study, it is possible that some individuals may feel emotionally distressed on viewing some of the images used in the study as they are highly graphic and may depict mutilation and death. Please note that the materials used is pertinent to the nature of the study and if at any point during the course of the experimental session you feel uncomfortable and wish to discontinue, please inform the researcher. Further some individuals may also feel frustrated and/or uncomfortable during Phase II of the study and experience test performance anxiety. Please be assured you are not being personally evaluated, and should you have any concerns you are welcome to ask the researcher questions at any point during the study. You may also contact counselling services (listed on the debriefing form), or contact the principal investigator Dr. Dawn Good, Registered Psychologist, should you choose.

By participating in this study you may benefit from a better understanding of how psychological research is conducted. You will also get a chance to be exposed to standardized and protected neuropsychological measures that are not readily available to the public. Additionally, results from this study will help further our understanding on brain-behaviour relationships. You will be invited to view the results of this study upon its completion (September, 2012). You may also contact the researchers via e-mail should you wish to view the results of the study.

Thank you in advance on behalf of the research team for your assistance and interest in this project!

Dr. Dawn Good	Tanvi Sharan	Jennifer Kerlew	Troy Hansen	Lisa Lam
Dawn.Good@brocku.ca	ts05jo@brocku.ca	jk07cv@brocku.ca	th08tp@brocku.ca	ll05oq@brocku.ca

Contact at (905) 688-5550 ext. 3556

Please complete the following:

[ ] I have read and understand the above information regarding the study.

[ ] I have received a copy of this form.

[ ] I understand that I may ask questions in the future.

[ ] I agree to participate in this study.

Participant's name (please print) -
_____

Participant's signature _____ Date: _____

[ ] I have explained this study to the participant

Researcher's signature _____ Date: _____

[ ] I acknowledge that I am participating in this study for a maximum of 2 research participation hours in a psychology course (see below) and will not receive monetary payment for this study.

COURSE (Please circle applicable course):

PSYC 1F90 2P12 2P20 2F23 2P36 2P37 2P39 Other: _____

Participant's signature _____ Date: _____

****PLEASE KEEP A COPY OF THIS CONSENT FOR YOUR RECORDS****

This project has been reviewed and received ethics clearance through the Office of Research Ethics Board (REB File # 11-188). If you have any questions or concerns regarding your rights as a participant, please contact the Research Ethics Officer via e-mail at reb@brocku.ca or may call 905 688 5550, Ext. 3035. If you have questions about the study or its procedures, or experience any adverse effects as a consequence of participating in this study, please feel free to contact us.

*****THANK YOU FOR YOUR PARTICIPATION!*****

Brock University Neuropsychology Cognitive Research Laboratory

Debriefing Statement

Dear Participant,

Thank you for your participation in this research study. As you are aware, this research study was conducted by Tanvi Sharan, Jennifer Kerlew, Troy Hansen, Lisa Lam and Dr. Dawn Good in the Psychology Department at Brock University. The purpose of the study was to investigate individual differences in empathy and its influence on prejudice and social decision making in university students who have/have not experienced a previous mild head injury (MHI). In conjunction, individual differences in affective traits and lifestyle preferences were also examined.

Ninety per cent of all brain injuries fall within the mild category, with as many as 33-50 percent university students reporting a history of MHI (e.g., concussion). Previous studies from our lab have shown that students who report a history of MHI, may exhibit certain behavioural tendencies different from (although minimally yet statistically) non-MHI controls. Furthermore, they exhibit lower arousal levels (e.g., lower electro-dermal activity, decreased pulse rate) and tend to be less stressed relative to their non-injured peers. Recent evidence suggests that such differences may exist in social decision making such that individuals reporting a history of MHI make riskier decisions relative to controls. Another aspect of social decision making pertains to one's social judgment of others (prejudice) and capacity for perspective taking/empathy. The purpose of the current study is to examine these individual differences (MHI status, personality) in empathy and its role in mediating one's judgement of others (prejudice) and consequently social decision making. We also intend to examine whether these differences may be influenced/ explained by certain personality variables and differences in levels of arousal.

The purpose of the study, and its emphasis on individual differences, particularly those associated with a history of head injury, was not disclosed initially due to possible subject bias – i.e., when participants are exposed to certain types of information prior to participation in a study, e.g., person characteristics, their responses may be influenced by that emphasis and they may behave or respond differently than they would have otherwise. Therefore, in order to avoid possible response bias, you were not informed of this interest until now.

Your participation is very important for us and helps further our understanding on the relationships between subtle brain functions and everyday responses to social situations. In case of any questions or concerns, please feel free to contact us at any time. You are invited to view the results of the study upon its completion (September, 2012). Findings from this research study may be presented at conferences and/or published. All data collected from this study will be numerically coded in order to maintain strict anonymity and confidentiality. It is crucial that you do not discuss the procedures of participating in this study (until the end of term academic year 2011-2012) with other students as it may affect our research results.

If you experienced any negative emotions as a result of participating in this research study and wish to speak with a counsellor please contact: **Brock University Counselling Services, ST 400, (905)**

688-5550, Ext. 3240, or the principal investigator Dr. Dawn Good, Registered Psychologist. **Should you like more information regarding head trauma please visit the following websites:** The Ontario Brain Injury Association (OBIA): http://www.obia.ca or the Ontario Neurotrauma Foundation (ONF): http://www.onf.org/. If you feel that you have not been treated according to the descriptions in this form, or your rights as a participant have been violated during the course of this project, you may contact the **Research Ethics Officer** at (905) 688-5550, Ext. 3035, citing **REB file #:** 11-188.

Thank you again for your time and participating in this study!!

If you have any questions or concerns please feel free to contact us:

Co- Investigators:

Tanvi Sharan, M.A. Candidate

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ts05jo@brocku.ca

(905) 688 5550, Ext., 3556

Principal Investigator:

Dr. Dawn Good, Ph.D., Psych.

Department of Psychology, Centre for Neuroscience

Brock University, St. Catharines, ON L2S 3A1

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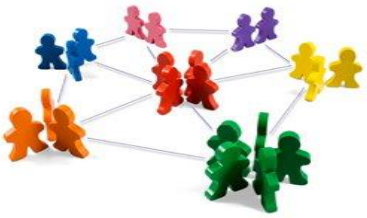
ll05oq@brocku.ca

(905) 688 5550, Ext. 3556

Participants Needed!!!

For research investigating

INDIVIDUAL DIFFERENCES IN ATTITUDES & SOCIAL DECISION MAKING



As a participant you will be asked to judge a variety of images & scenarios & complete questionnaires, to be eligible for

2.0 research participation hours!!!

To participate in this study you must be fluent in English.

For more information or to sign up please visit SONA or contact:

Tanvi Sharan	Jennifer Kerlew	Troy Hansen	Lisa Lam
ts05jo@brocku.ca	Jk07cv@brocku.ca	th08tp@brocku.ca	ll05oq@brocku.ca

Supervisor: Dr. Dawn Good Dawn.Good@brocku.ca (ext. 3556)

This study has been reviewed by and received ethics clearance through the Office of Research Ethics, Brock University (REB # 11-188) 905-688-5550 ext. 3035

Individual Differences in empathy & social decision making *Email:* ts05jo@brocku.ca, jk07cv@brocku.ca, *or* th08tp@brocku.ca

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APPENDIX C: DATA COLLECTION MATERIALS

IMAGES & SCENARIOS USED IN THE EPT

**Highlighted Cases Identified as problem images (PI) and were excluded from the final analyses

Neutral 1

Confirming Scenario: You are witnessing a woman waiting to check out at a gas station.

Contrasting Scenario: You are witnessing a snapshot of a woman taken from a hidden camera who is about to shoplift.

Neutral 2

Confirming Scenario: You are witnessing a woman playing a card game on her laptop.

Contrasting Scenario: You are witnessing a woman overwhelmed by her excessive workload who is currently working on a big presentation that will determine her raise

Neutral 3

Confirming Scenario: You are witnessing a man (insert name?) assessing the quality of his produce.

Contrasting Scenario: You are witnessing a local farmer worried about the effects of the drought on his yield.

Neutral 4

Confirming Scenario: You are witnessing an employee giving their fingerprints for security clearance.

Contrasting Scenario: You are witnessing a police officer taking the fingerprints of a suspect in a murder case.

Neutral 5

Confirming Scenario: You are witnessing a group of children playing hide-and-seek.

Contrasting Scenario: You are witnessing a child who is often excluded from group activities and does not have

any friends.

Neutral 6

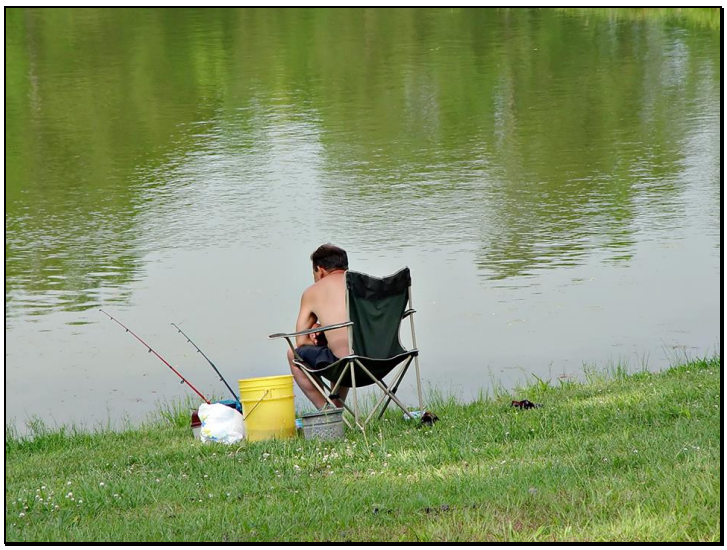
Confirming Scenario: You are witnessing a child waiting for a school bus.

Contrasting Scenario: You are witnessing a child who lost his way while coming home from school.

Neutral 7

Confirming Scenario: You are witnessing a receptionist addressing calls.

Contrasting Scenario: You are witnessing a woman receiving a distressing call at work with the news that her mother has passed away.



Neutral 8

Confirming Scenario: You are witnessing a man enjoying his weekend.

Contrasting Scenario: You are witnessing a man who just got laid off due to cutbacks.

Neutral 9

Confirming Scenario: You are witnessing children walking home from the beach.

Contrasting Scenario: You are witnessing two orphans searching for bottle caps to get enough money for food.

Neutral 10

Confirming Scenario: You are witnessing a doctor waiting for her next patient.

Contrasting Scenario: You are witnessing a doctor who just got paged that her patient just died.

Neutral 11

Confirming Scenario: You are witnessing a man searching for his wallet.

Contrasting Scenario: You are witnessing a terrorist on a mission to destroy a historical landmark.

Neutral 12

Confirming Scenario: You are witnessing a construction worker guiding the placement of a steel beam.

Contrasting Scenario: You are witnessing a construction worker losing his balance while on the job.

Negative 1

Confirming Scenario: You are witnessing a victim of a fatal car crash who was killed by the hands of an impaired driver.

Contrasting Scenario: You are witnessing a dummy in a forensic laboratory for the purposes of medical training.

Negative 2

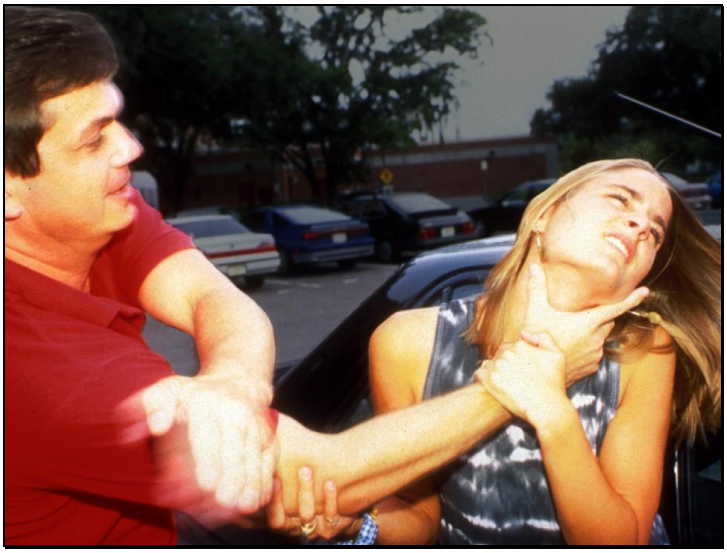
Confirming Scenario: You are witnessing a woman who is a victim of domestic violence

Contrasting Scenario: You are witnessing a picture from the portfolio of a theatrical make-up artist.

Negative 3

Confirming Scenario: You are witnessing an altercation between a gang member and a bystander on the subway.

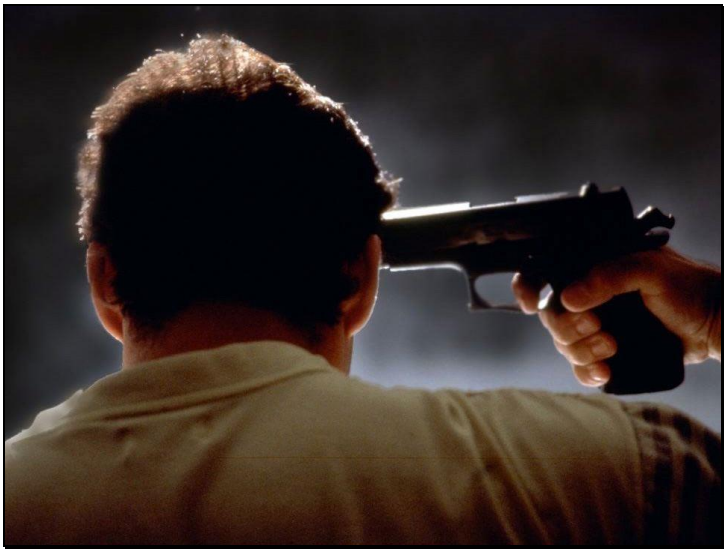
Contrasting Scenario: You are witnessing a snap shot from a music video.



Negative 4

Confirming Scenario: You are witnessing an abduction of a student in the parking lot of a university.

Contrasting Scenario: You are witnessing a demonstration during a self-defence class.



Negative 5

Confirming Scenario: You are witnessing a gentleman contemplating taking his own life after struggling with depression.

Contrasting Scenario: You are witnessing a public health announcement on suicide awareness.

Negative 6

Confirming Scenario: You are witnessing the effects after a bomb was detonated in a bank, injuring a number of individuals.

Contrasting Scenario: You are witnessing a movie clip from an action film.

Negative 7

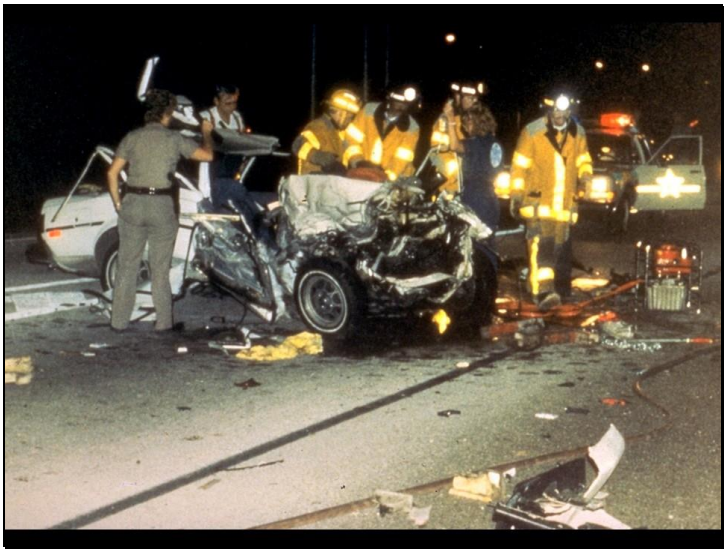
Confirming Scenario: You are witnessing a sinking cruise which had numerous casualties.

Contrasting Scenario: You are witnessing the destruction of a retired ship.

Negative 8

Confirming Scenario: You are witnessing a man being set on fire during a revolt.

Contrasting Scenario: You are witnessing a stuntman on the job.



Negative 9

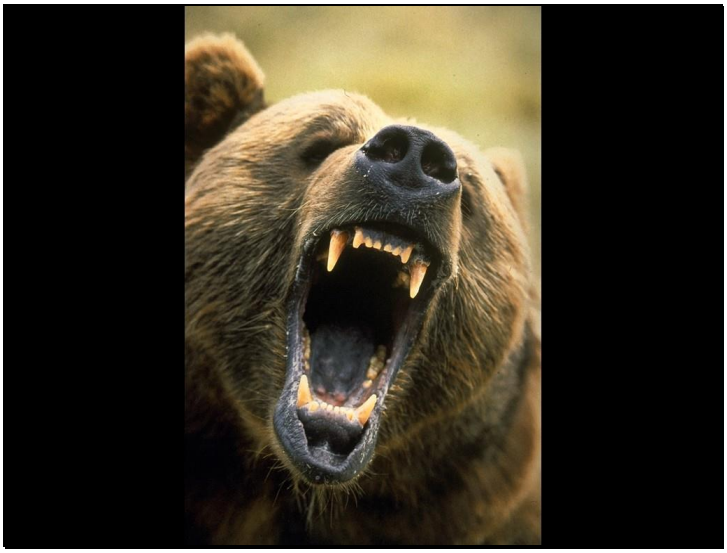
Confirming Scenario: You are witnessing a car crash involving a family vehicle with multiple causalities.

Contrasting Scenario: You are witnessing a training session for first responders.

Negative 10

Confirming Scenario: You are witnessing a child about to be killed because his brother refused to join the rebel forces.

Contrasting Scenario: You are witnessing a soldier watching the child return safely back to his village.



Negative 11

Confirming Scenario: You are witnessing a grizzly bear ready to attack at a campsite.

You are witnessing a grizzly bear at the zoo

Contrasting Scenario: You are witnessing a grizzly bear at the zoo

.

Negative 12

Confirming Scenario: You are witnessing a child soldier from a third world country.

Contrasting Scenario: You are witnessing a child practicing for an upcoming skeet shooting competition.

QCAE

Using the 4 point scale shown below, please indicate to what degree the following statements apply to you.

1= strongly agree 2= slightly agree 3= slightly disagree 4= strongly disagree

2. I sometimes find it difficult to see things from the "other guy's" point of view.	*1*	*2*	*3*	*4*
3. I am usually objective when I watch a film or play, and I don't often get completely caught up in it.	*1*	*2*	*3*	*4*
4. I try to look at everybody's side of a disagreement before I make a decision.	*1*	*2*	*3*	*4*
5. I sometimes try to understand my friends better by imagining how things look from their perspective.	*1*	*2*	*3*	*4*
6. When I am upset at someone, I usually try to "put myself in his shoes" for a while.	*1*	*2*	*3*	*4*
7. Before criticizing somebody, I try to imagine how I would feel if I was in their place.	*1*	*2*	*3*	*4*
8. I often get emotionally involved with my friends' problems.	*1*	*2*	*3*	*4*
9. I am inclined to get nervous when others around me seem nervous.	*1*	*2*	*3*	*4*
10. People I am with have a strong influence on my mood.	*1*	*2*	*3*	*4*
11. It affects me very much when one of my friends seems upset.	*1*	*2*	*3*	*4*
12. I often get deeply involved with the feelings of a character in a film, play, or novel.	*1*	*2*	*3*	*4*

13. I get very upset when I see someone cry.	*1*	*2*	*3*	*4*
14. I am happy when I am with a cheerful group and sad when the others are glum.	*1*	*2*	*3*	*4*
15. It worries me when others are worrying and panicky.	*1*	*2*	*3*	*4*
16. I can easily tell if someone else wants to enter a conversation.	*1*	*2*	*3*	*4*
17. I can pick up quickly if someone says one thing but means another.	*1*	*2*	*3*	*4*
18. It is hard for me to see why some things upset people so much.	*1*	*2*	*3*	*4*
19. I find it easy to put myself in somebody else's shoes.	*1*	*2*	*3*	*4*
20. I am good at predicting how someone will feel.	*1*	*2*	*3*	*4*
21. I am quick to spot when someone else is interested or bored with what I am saying.	*1*	*2*	*3*	*4*
22. Other people tell me I am good at understanding how they are feeling and what they are thinking.	*1*	*2*	*3*	*4*
23. I can easily tell if someone else is interested or bored with what I am saying.	*1*	*2*	*3*	*4*
24. Friends talk to me about their problems as they say that I am very understanding.	*1*	*2*	*3*	*4*
25. I can sense if I am intruding, even if the other person does not tell me.	*1*	*2*	*3*	*4*

25. I can easily work out what another person might want to talk about.	*1*	*2*	*3*	*4*
26. I can tell if someone is masking their true emotion.	*1*	*2*	*3*	*4*
27. I am good at predicting what someone will do.	*1*	*2*	*3*	*4*
28. I can usually appreciate the other person's viewpoint, even if I do not agree with it.	*1*	*2*	*3*	*4*
29. I usually stay emotionally detached when watching a film.	*1*	*2*	*3*	*4*
30. I always try to consider the other fellow's feelings before I do something.	*1*	*2*	*3*	*4*
31. Before I do something I try to consider how my friends will react to it.	*1*	*2*	*3*	*4*

ELQ

Please fill in or circle an answer for each of the following. If you have any questions regarding clarification, please ask the researcher. Thank you for your time and effort!

1. How old are you? ____

2. Gender? M___ F____

3. What is the highest level of education you have presently completed?
   a Less than high school

   b. High School/Grade 12

   c. University 1 2 3 4 4+ (Years)

   d. College 1 2 3 4 4+

4. What is your major (e.g. English, Psychology, Science)? _____

5. Handedness
   a. Right
   b. Left
   c. Both

6. Have you ever been hospitalized for (circle any that apply):
   a. Fractures Y N
   b. Illness Y N
   c. Surgery Y N
   d. Neurological complications Y N
   e. Other Y N

   If you answered Y to any of the above, briefly please provide details:

   e.g. How old were you? How did it happen? _____

   _____

   _____

7. Have you ever been diagnosed with a neurological condition? Y N

8. Have you ever been diagnosed with a psychiatric condition? Y N

9. Are you currently taking any prescribed medications for a neurological or psychiatric condition? Y N

    a. If Yes, if you wish to disclose what medication please do so: _____

10. Have you ever sustained an injury to your head with a force sufficient to alter your consciousness (e.g. dizziness, vomiting, seeing stars, or loss of consciousness, or confusion)? Y N
    [If you answered **no** to this question you may move ahead to question 22]

If yes to question 10, please answer the following questions (if you have had more than one injury, please refer to the *most recent* time you injured your head):

11. If you answered yes to question 10, did you experience these symptoms for more than 20 minutes? Y N

12. Did you experience a loss of consciousness associated with the head injury? Y N

    i. If so, how long was the loss of consciousness?
        i. [ ] < 5 minutes
        ii. [ ] < 30 minutes
        iii. [ ] < 24 hours
        iv. [ ] < 1 week
        v. [ ] < 1 month
        vi. [ ] > 1 month

13. How did you injure your head?

    i. [ ] Motor vehicle collision
    ii. [ ] Sports-related injury
    iii. [ ] Falling
    iv. [ ] Other Please Specify:_____

14. Please briefly describe the incident during which the head injury occurred:

15. Please answer the following questions:

    a. Did the head injury result in a concussion? Y N

    b. Did it require stitches? Y N

    c. Did you receive medical treatment for your injury? Y N

    d. Did you stay overnight at a medical care facility? Y N

    e. Have you ever been diagnosed or classified as having a Learning Disability? Y N

    f. Approximately how old were you at the time ___

    g. How many months or year(s) have past since you hit your head? ___

16. Have you sustained *more than one* injury to your head with a force sufficient to alter your consciousness (e.g. dizziness, vomiting, seeing stars, or loss of consciousness, or confusion)? Y N

    a. **If yes**, how many times? ___

17. **If you answered yes to question 16**, did you experience these symptoms for more than 20 minutes? Y N

If you responded yes to question 16, please answer the following with respect to your *least recent* head injury:

18. Did you experience a loss of consciousness associated with the least recent head injury? Y N
    i. If so, how long was the loss of consciousness?
        i. [ ] < 5 minutes
        ii. [ ] < 30 minutes
        iii. [ ] < 24 hours
        iv. [ ] < 1 week
        v. [ ] < 1 month
        vi. [ ] > 1 month

19. How did you injure your head?

    i. [ ] Motor vehicle collision
    ii. [ ] Sports-related injury
    iii. [ ] Falling
    iv. [ ] Other Please Specify:_____

20. Please briefly describe the incident during which the least recent head injury occurred:

_____

_____

_____

21. Please answer the following questions:

    a. Did the head injury result in a concussion? Y N

    b. Did it require stitches? Y N

    c. Did you receive medical treatment for your injury? Y N

d. Did you stay overnight at a medical care facility? Y N

e. Approximately how old were you at the time ___

f. How many months or year(s) have past since you hit your head? ___

22. Have you ever experienced any other neural trauma (e.g. stroke, anoxia)? Y N
    a. **If yes**, please explain:

_____

_____

23. Do you smoke cigarettes? Y N

If yes, approximately how many a day? _____

24. Do you regularly engage in consuming alcohol? Y N

    a. If yes, how many drinks per week do you consume? _____
    b. On average how many drinks would you consume in one outing? _____

25. Do you engage in recreational drug use (e.g. smoke marijuana, drop ecstasy, etc.)? Y N

26. Did you consume caffeine today (e.g. coffee, tea, energy drink, chocolate)? Y N

    a. **If yes**, how much?
    1 2 3 more than 3

    b. **If yes**, how much time has past since you last consumed caffeine today?

Less than 1 hour More than 1 hour

27. Do you have sensitivity to perfumes or scents? Y N

If yes, please rate your sensitivity:

Not at all Very

1 2 3 4 5 6 7 8 9

28. Do you have a valid driver's license? Y N

a. **If yes**, how long have you had a driver's license? 1-3 years 4-6 years 7+ years

29. Do you wear glasses or contacts? Y N

30. Do you live: on your own with roommates other

with parents/guardians with partner

31. How many university credits are you taking this semester?

0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6

32. On a scale of 1 to 9 rate your enjoyment of academics:

Not at all Very

1 2 3 4 5 6 7 8 9

33. Have you ever received any extra assistance during your educational history? Y N

Please circle any that apply and indicate when you received the assistance:

E = Elementary school H = High school U = University

a. Learning resource teacher E H U
b. Tutor E H U
c. Educational assistant E H U
d. Speech Language Pathologist E H U
e. Occupational Therapist E H U
f. Physical Therapist E H U
g. Other: Please Specify:_____ E H U

34. On a scale of 1 to 9 rate your enjoyment of your life situation:

Not at all Very

1 2 3 4 5 6 7 8 9

35. On a scale of 1 to 9 how stressful would you rate your day-to-day life:

Not at all Very

1 2 3 4 5 6 7 8 9

36. What extracurricular sport(s) did you play in:

a. Elementary school:
    i. please describe/name the sport(s) – indicate if it was recreational (R) or competitive (C)_____

    ii. How often do you play sports (per week)?_____

b. High school:
    i. please describe/name the sport(s) – indicate if it was recreational (R) or competitive (C)_____

    ii. How often do you play sports (per week)?_____

c. Currently play sports in University
   i. please describe/name the sport(s) – indicate if it was recreational (R) or competitive (C)_____

   ii. How often do you play sports (per week)?_____

37. Do you exercise regularly? Y N

a. **If yes**, how many times a week do you exercise? _____

Please describe:_____

_____

38. When you ride a bike/skate/etc. do you wear a helmet? Y N NA

39. Do you regularly engage in relaxation techniques (e.g. deep breathing or yoga): Y N

a. **If yes**, how many times a week do you engage in relaxation methods?_____

Please describe:_____

40. Was last night's sleep typical for you? Y N

If No, what was different (better, worse) ? _____

Why was it different? (stress, room temperature, noise, etc.)

_____

Please indicate how well you slept last night by circling a number:

Worst Possible 1 2 3 4 5 6 7 Best Possible

Sleep Sleep

Please indicate how you feel right now by circling a number:

Very Sleepy 1 2 3 4 5 6 7 Very Alert

41. Have you had anything out of the ordinary occur in the past day or so? Y N
If yes, please explain:

_____

_____

_____

42. Circle any of the following that apply to your experience over the past 6 months:

Moved	Death of a family member
New Job	Death of a close friend
Loss of Job	Financial Difficulties
Loss of Relationship	Illness of someone close to you
New Relationship	Personal Illness/Injury
Reconciliation with partner	New Baby
Reconciliation with Family	Wedding/ Engagement (self)
Divorce (of self or parents)	Vacation

Entered 1st year at university Disrupted Sleep

43. Please indicate how your day has been so far by circling a number:

Calm 1 2 3 4 5 6 7 8 9 10 Busy

Pleasant 1 2 3 4 5 6 7 8 9 10 Unpleasant

NOT Stressful 1 2 3 4 5 6 7 8 9 10 VERY Stressful